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A STUDY OF THE ALDRIDGE FORMATION

ST. MARY LAKE AREA

BRITISH COLUMBIA

A. D. BERRY

APRIL 1951

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FRONTISPIECE

Looking northeast toward junction of East fork, North fork, and West fork of the St. Mary river.

THE UNIVERSITY OF ALBERTA.

A STUDY OF THE ALDRIDGE FORMATION, ST. MARY LAKE AREA, BRITISH COLUMBIA.

A THESIS

SUBMITTED TO THE SCHOOL OF GRADUATE STUDIES IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE.

FACULTY OF ARTS AND SCIENCE.

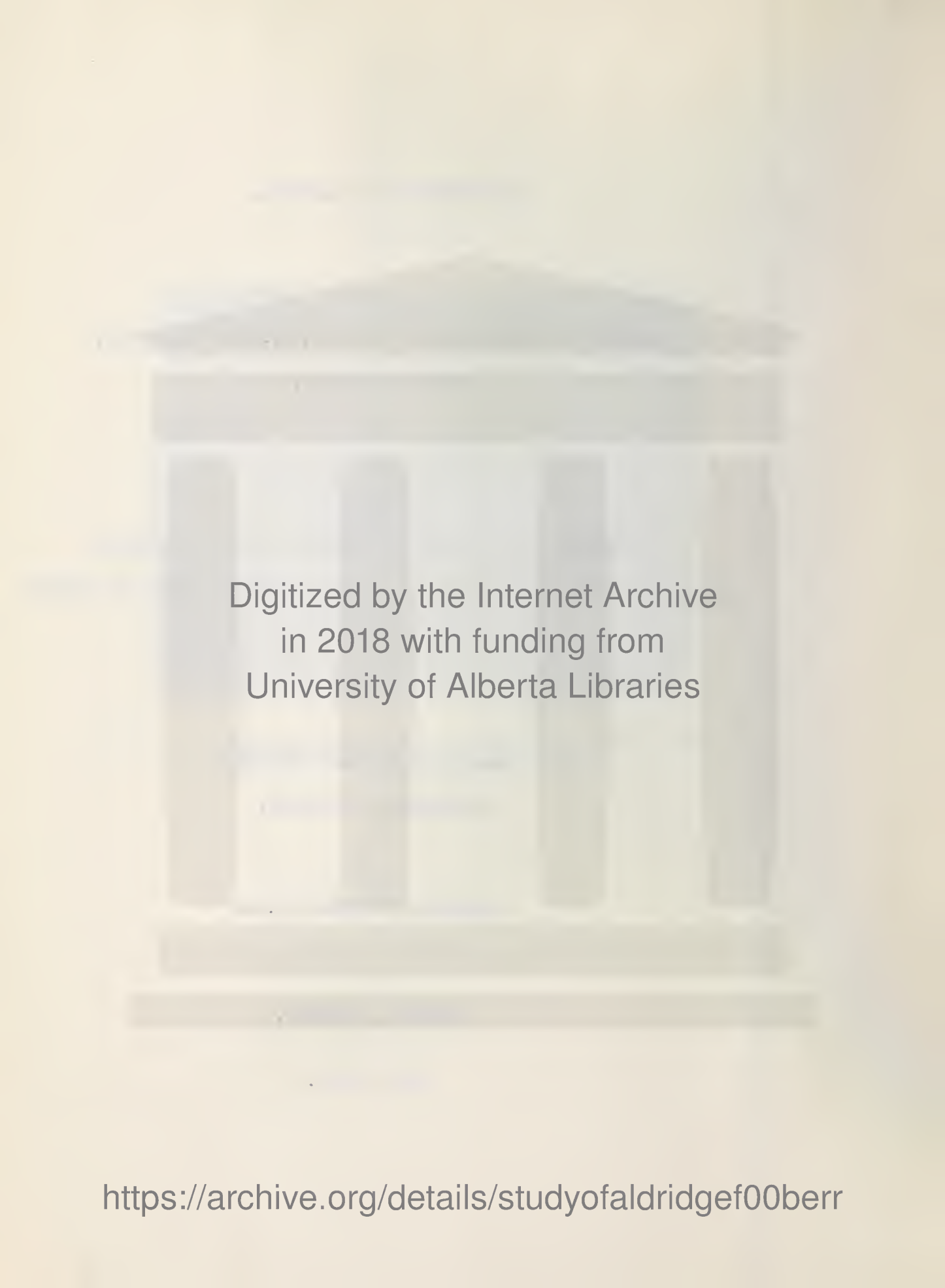
DEPARTMENT OF GEOLOGY.

by

ANDREW DAVID BERRY, B.Sc.

EDMONTON, ALBERTA.

APRIL, 1951.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Abstract.

The Aldridge formation is the oldest formation of the Lower Purcell series of Precambrian rocks, St. Mary Lake area, British Columbia.

This formation was studied in the field, divided into three members and mapped as such during the field season of 1950. Thin sections from field specimens were studied at the University of Alberta during the winter term of 1950-1951.

The Lower Aldridge member consists of 5,000 feet of finely lined, massive quartzites and argillaceous quartzites. Abundance of crossbedding indicated shallow water deposition on the tidal flats of a mildly unstable shelf.

The Middle Aldridge member consists of 10,000 feet of quartzite and argillaceous quartzite. The quartzite occurs in massive grey and rusty weathering beds from a few inches thick up to 8 feet thick. The quartzite beds are usually topped by thinner lined or unlined dark argillaceous partings. Crossbedding is not dominant though there is considerable evidence of other primary features indicating shallow water deposition.

The Upper Aldridge member consists of 1,000 feet of rusty weathering, finely lined argillaceous quartzite and argillite. This member has the attributes of having been deposited in an intracratonic basin. It lacks any primary features of shallow water deposition.

The sediments of the Aldridge formation are poorly sorted and range in grain size from the clay fractions to the medium sand size of Wentworth's scale. They are believed to be first cycle

deposits originating from a granitic terrain.

Regional metamorphism has caused extensive recrystallization of the argillaceous components to form chlorite, biotite and lesser amounts of garnet and zoisite.

A STUDY OF THE ALDRIDGE FORMATION, ST. MARY LAKE AREA, BRITISH COLUMBIA

GENERAL INTRODUCTION.

During the summer of 1950 the writer was employed by the Department of Mines and Technical Surveys on one of their survey parties in the field. In the capacity of Senior Assistant he acted under the direction of Dr. G. B. Leech of Ottawa. A beginning was made in the mapping on the scale of 1 mile to 1 inch of the St. Mary Lake area, B. C. The actual map-area is bounded by 49° 30' - 49° 45' N. latitude, and 116° 00' - 116° 30' W. longitude. The town of Kimberley lies off the map-area but in close proximity to the northeast corner. Part of the Sullivan mine is actually within the confines of the northeast corner of the map-area. The map-area extends from the foothills of the Purcell range on the east to approximately the center of the Purcell range on the west. No distinct physiographic features mark the north and south boundaries. The deep valley of the easterly-flowing St. Mary river cuts across the center of the map-area.

PREVIOUS WORK.

The first record of any geological work done in the Purcell range in southeast Kootenay is contained in a report by Bauerman (1882).* Bauerman worked for the International Boundary Commission from 1859 to 1861. In investigating the area between Tobacco Plains and Creston (see map, p.4) he recognized a series of thick, well bedded unfossiliferous rocks which he believed to be Precambrian in age. He did not originate any names.

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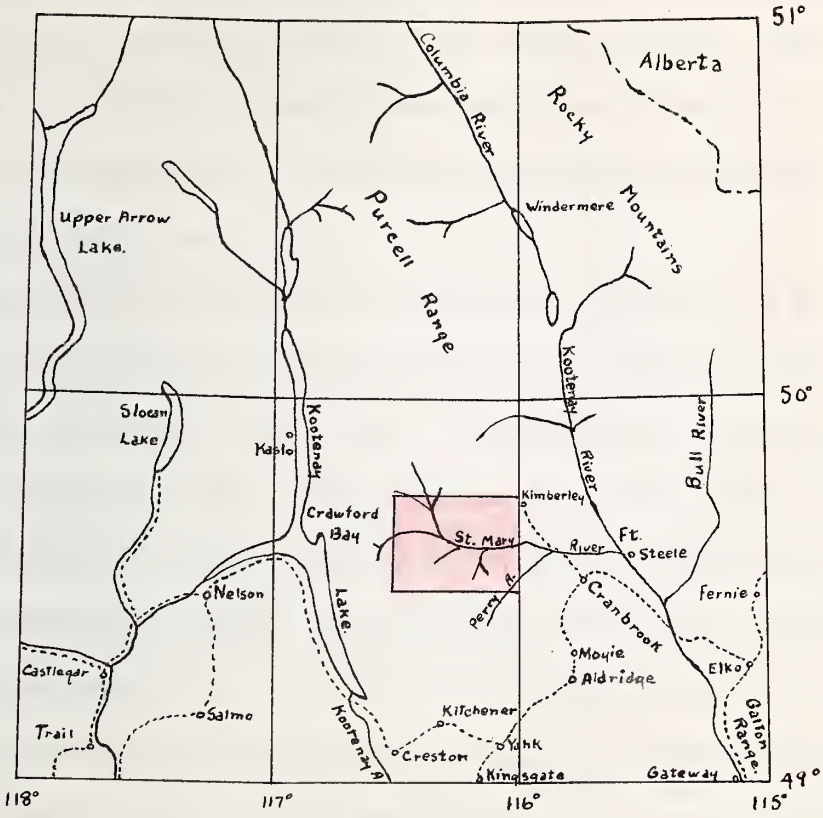
*See "Bibliography" pp.52-53.

Subsequently Dawson (1885) placed the rocks of the Purcell range in the Cambrian as did McEvoy (1899).



Location of the map-area in southeastern British Columbia.

R. A. Daly (1904) was the first person to make a systematic subdivision of this thick group of sediments into formations. While working for the Boundary Commission between the east and wast crossings of the Kootenay river, he divided the sediments into four formations. In ascending order his group included the Creston, Kitchener, Moyie and Yahk formations. Daly's Creston consisted of grey and greenish weathering quartzite. His Kitchener consisted mainly of quartzite and metargillite, the Moyie of red and grey argillaceous strata with subordinate quartzite. Overlying this, the Yahk formation consisted of quartzite.

Daly in his report, "Geology of the North American Cordillera" (1912), has dispensed with the Yahk formation by including these quartzites in the Moyie formation of his Purcell series. Daly has considered a lower part of the Creston as being Precambrian whereas the remaining Creston with the Kitchener and Moyie formations is placed in the Cambrian.

Subsequent to Daly, Schofield entered the area and in his first report (1911) has indicated that much of Daly's Kitchener formation is older than the Creston. Therefore, Schofield gave the name "Aldridge" to this new formation and added to it a portion of Daly's Creston as well. Schofield puts Daly's Moyie formation, in the neighborhood of Yahk, into the Siyeh formation. In his Purcell series Schofield has included the Gateway formation which is the youngest formation included to this time. The occurrence of Purcell lavas between the Gateway and Siyeh formation enabled Schofield to trace these two previously named formations from the Galton range of the Rocky mountains westward across the Rocky Mountain Trench to the Purcell range.

Schofield (1915) considers all the Purcell series to be Precambrian in age. The Purcell series at this time was considered to include all the rocks below the unconformity which marks the top of the Precambrian. No Cambrian had as yet been found in the Purcell range when Schofield indicated his Purcell series as being Precambrian in age. This was done by a study of the Precambrian-Cambrian relationships near Elko, B. C. (Mus. Bull. #2). Subsequently work near Cranbrook (Mus. Bull. #35) revealed the presence

of Cambrian beds lying unconformably on the Purcell series, thus strengthening the interpretation of the Purcell series as being Precambrian in age.

J. F. Walker (1926) divided the Purcell series into a lower part and an upper part. The base of the Upper Purcell series is defined as being the horizon of the uppermost Purcell lava at the boundary of the Gateway and underlying Siyeh. This leaves the Aldridge, Creston, Kitchener and Siyeh formations in the Lower Purcell series.

This arrangement has been modified added to by Rice (1937) who placed the Fort Steele formation below the Aldridge formation. The Fort Steele formation was recognized on the east side of the Rocky Mountain Trench north of Fort Steele, B. C. It has not yet been recognized on the west side of the trench in the St. Mary Lake area. Thus, in the St. Mary Lake area we find the following formations of the Lower Purcell series.

Precambrian-Lower Purcell series
- Siyeh
- Kitchener
- Creston
- Aldridge (base not seen)

The thickness of the Lower Purcell series is estimated by Rice (1941) to be 29,800 feet with 16,000 feet of this included in the Aldridge formation.

This was the extent to which geological investigation had been carried on in the southern part of the Purcell range, and more particularly in the St. Mary Lake area, when the writer entered the field in the season of 1950 with a field survey party of the Department of Mines and Technical Surveys.

OBJECT OF THE WRITER'S INVESTIGATIONS.

The Aldridge formation is the oldest known formation of the Lower Purcell series of rocks in the St. Mary Lake area.

Many investigators in the past have formed conclusions on the environment of deposition of the Lower Purcell series. No specific study has been made, nor has any report dealt specifically with this phase of Precambrian sedimentation in this area. Previous to entering the area in 1950 the writer was aware of this lack, and the absence of any purely lithological study of these sediments. Consequently, a study of the lithology of the Aldridge formation was undertaken and, where possible, inferences as to the environment of deposition of these sediments were made.

The writer spent one summer in this area. The Aldridge formation is 16,000 feet thick. With a limited time to spend on a large thickness of sediments, it can be realized that at best this report must be incomplete. The writer hopes that this treatise does provide some coherent information on aspects of Precambrian sedimentation in this area of British Columbia.

METHODS OF INVESTIGATION.

a. Field Work.

The mapping was done on a base map on a scale of 1 mile to 2 inches. Traverses were run approximately one quarter mile apart. Owing to the extremely rugged nature of the terrain, traverse lines were controlled to a great extent by topographic features. Traverse lines generally followed stream courses and ridges. Sufficient control was obtained using the highly detailed and accurate contour maps in conjunction with a pocket barometer giving elevations to the nearest 25 feet. When necessary this was supplemented by triangulation using a Brunton compass.

Careful attention was paid to lithological changes in the sediments. The structure was worked out in detail. Particular attention was paid to primary features which existed in quantity in various localities, and were absent in other localities. Representative samples of various rock types of the Aldridge formation were collected as well as examples of primary sedimentary features from this formation.

b. Laboratory Work.

The study of thin sections from the Aldridge sediments provided the basis for laboratory work.

A heavy mineral separation was made on various rock samples for which a thin section existed. A small amount of the sample was taken (20 - 25 grams) and fine chips were made of this. These chips were put in a mortar and ground with a pestle. Grinding was

carried on until the material would pass through a 100 mesh screen (Central Scientific Co.). This material was then put in bromoform in a standard separation apparatus (Krumbein, 1933) and the heavy minerals allowed to separate out. These heavy minerals were then mounted in permanent mounts with Canada balsam. The grinding to 100 mesh was found to be very satisfactory. The grains were small enough to allow the use of a high power microscope lens over a cover glass. Though many heavy minerals were broken, they were not so small but that whole separation of individual heavy minerals was obtained.

The samples used were quartzites or argillaceous quartzites. As a consequence of their hard nature much contaminating material with heavy minerals still attached settled to the bottom of the bromoform. Conversely, heavy minerals were maintained at the top of the liquid with minerals of lighter specific gravity. The writer thus did not record any weights of samples used or heavy minerals obtained as, at best, these would be inaccurate and of little value. Consequently, the heavy mineral studies were mainly qualitative with the added noting of any preponderance of one heavy mineral type over other heavy mineral types.

The writer was unable to obtain good photographs while on the Aldridge formation in the field. Macrophotographs of various specimens brought back from the field were thus made with facilities provided by the Department of Geology at the University of Alberta. Microphotographs were also made in the Department. Super pan press

$3\frac{1}{4}$ inches by $4\frac{1}{4}$ inches film was used for photographing the rock specimens and for the microphotographs.

As no adequate geologic map existed for the St. Mary Lake area the writer made his own. Two "Geological Survey of Canada" preliminary topographic maps were used as a base and the required information, including every 500 foot contour interval, was copied onto tracing paper. This map, on transparent paper, was then sent to a printing company and used as a negative for reproduction.

ACKNOWLEDGMENTS.

The writer wishes to thank all the members of the staff of the Department of Geology at the University of Alberta for the kind assistance they have rendered him in many ways.

Particular thanks are extended to Dr. R. E. Folinsbee under whose guidance this study was carried out.

Particular thanks are also extended to Dr. G. B. Leech of Ottawa under whose direction the writer worked during the summer of 1950. His kind consideration brought out many points of interest for study which might otherwise have been missed.

GEOGRAPHY OF THE AREA.

a. Physical.

The east side of the St. Mary Lake area borders on the Rocky Mountain Trench. Here the mountains are subdued with rounded tops completely covered with forest growth. Elevations range up to 6,500 feet.

Elevations increase towards the west until heights of 9,000 feet are present in the central and western parts of the map-area. This results in numerous barren peaks as timber line is 7,500 to 8,000 feet above sea level. The whole map-area is drained by the St. Mary river which flows in an easterly direction in a wide, deep valley through the center of the map-area. In the western part the river is at the level of the valley floor which is 3,200 feet above sea level. Towards the eastern part of the map-area the river has cut a deep channel through glacial debris and the clays and silts of a glacial or post-glacial lake.

Glacial activity has been extensive. This is seen in the well rounded glaciated valleys, the hanging valleys, and in the presence of numerous cirques, many of which contain small lakes.

The forest growth is quite extensive in this southern part of British Columbia. Some of the better known types of trees are cedar, hemlock, pine, spruce, balsam and tamarack.

Wild life appeared to be quite plentiful. Most commonly seen were deer, moose, and black bear. Goats were not plentiful but were seen several times in the higher parts of the area.

b. Cultural.

The rugged nature of the area has limited man's activity. At present one operating lumber camp exists in the area at the junction of Redding creek with St. Mary river. An active sawmill is situated at the outlet of St. Mary Lake.

One road follows up St. Mary valley as far as the junction of North Fork with East Fork. Pack trails carry on from the end of this road up the three forks of the St. Mary river. The pack trail up West Fork crosses Rose Pass and goes to Crawford Bay on Kootenay Lake. This trail has been in use since the 1890's when the area was being thoroughly prospected by prospectors following the gold rushes on Wildhorse river near Fort Steele and on Perry river. Most of the basins contain one or two cabins dating back to those times. A little searching usually reveals a pit or an adit. Some of these adits have entailed much labor since more than one was seen penetrating rock to distances of well over 100 feet. These were great accomplishments when it is remembered that they were drifted in the days of "hand steeling".

Pack trails follow up the greater number of major valleys in the map-area. A road runs up Perry creek and a branch road up Sawmill creek.

In actuality, there is little human activity in the St. Mary Lake area considering its proximity to the well populated centers of Kimberley and Cranbrook.

A STUDY OF THE ALDRIDGE FORMATION

INTRODUCTION.

In any scientific study there are certain limiting factors controlling the extent and nature of the investigator's work. This is particularly true in a study of sedimentation and sedimentary rocks.

Primarily, the writer does not attempt to approach the subject by applying the use of known laws of sedimentation and tectonism and interpolating back to aspects of Precambrian sedimentation. Rather an approach is made by considering the data available, its evaluation and, finally, the application of the principles evolved in an attempt to interpret the Precambrian sedimentary conditions in effect during the deposition of the Aldridge formation.

FIELD CHARACTERISTICS OF THE ALDRIDGE FORMATION.

The Aldridge formation is the lowest formation of the Lower Purcell series (see p.7) in the St. Mary Lake area.

This formation is approximately 16,000 feet thick (Rice, 1941). This great thickness of sediments has remarkable lithological similarity from bottom to top, and correlation from outcrop to outcrop has proven very difficult. Previous investigators have never subdivided this formation into members in any of their reports.

On entering the area in 1950 it was found that the geologists of the Consolidated Mining and Smelting Company had a three part division of the Aldridge formation which was applicable in the environs of the Sullivan mine. As this three part division was found to hold in the St. Mary Lake area it was utilized in the

mapping of this area during the summer of 1950. At the present stage of investigation the writer does not know whether this subdivision will be maintained as constituting three members of the Aldridge formation or whether three new formational names will be originated. The writer prefers in this thesis to refer to the units as the Lower Aldridge member, Middle Aldridge member, and Upper Aldridge member of the Aldridge formation.

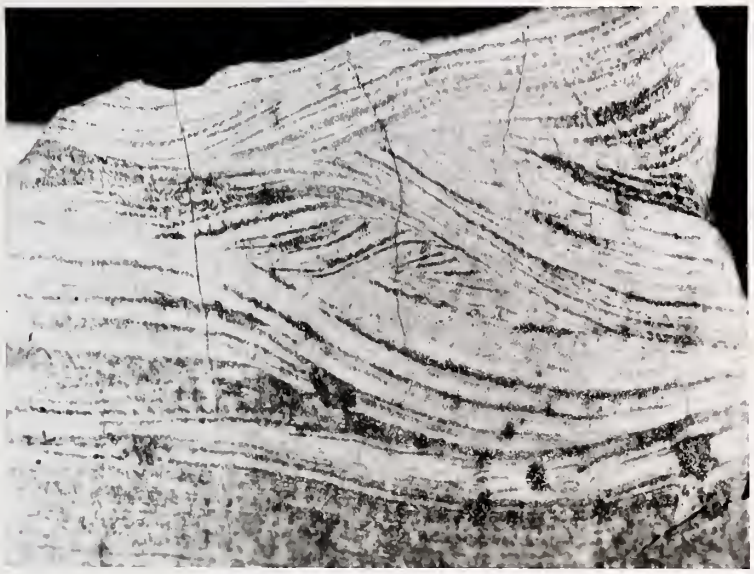
LOWER ALDRIDGE MEMBER.

The Lower Aldridge member contains 5,000 feet of the 16,000 feet of sediments in the Aldridge formation.

This member was mapped as quartzite and argillaceous quartzite. A quick distinction was made by scratching the specimen with a hammer tip. If a scratch could be made and material powdered then it was classed as argillaceous quartzite. If little effect was observable the rock was called a quartzite. The rocks were so universally fine-grained that any distinction between quartzite and argillaceous quartzite on a grain size basis was discounted.

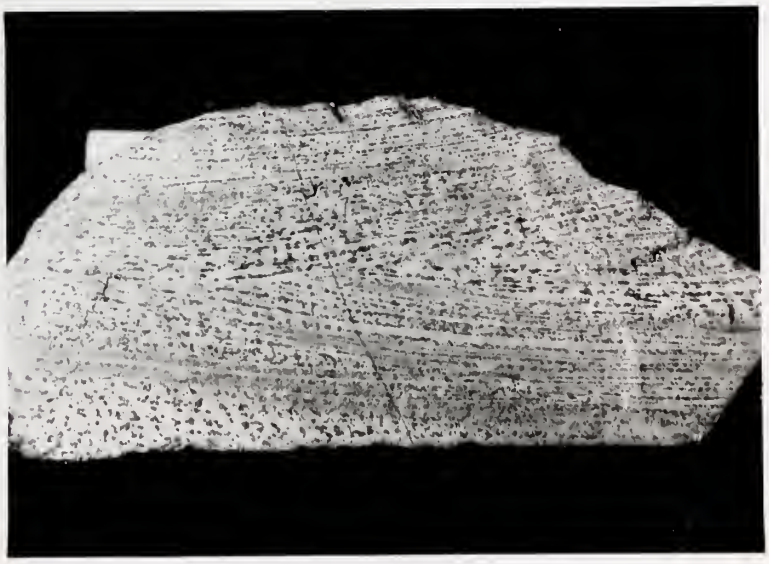
The Lower Aldridge member is characterized by fine laminations and a finely lined appearance of the quartzite phase. These fine laminations and fine lines are almost universal throughout the member. On close inspection the fine lines were found to be an expression of biotite in the bedding planes of the rock. Where they are not present a purer massive quartzite in beds up to 1 foot thick was found. The finely lined quartzite was found to dominate over the argillaceous quartzite and the unlined more massive appearing quartzite.

Plate 1.



1a. Crossbedding. (2 times actual size)

Lower Aldridge member; (?)
Delicate lines preserve the characteristic features of crossbedding. An accumulation of biotite along the bedding provides the contrast.



1b. Crossbedding. (½ actual size)

Lower Aldridge member; (?)
An accumulation of biotite along the bedding planes provides the contrast to show the features of crossbedding.

Bedding fissility provides units varying in thickness from a few inches to about $2\frac{1}{2}$ feet at the maximum. Regardless of the thickness of the beds the finely lined effect persists throughout the bed.

The fine lining of the beds is a major factor in portraying primary features of sedimentation which would otherwise be unrecognized. In all instances these primary features observed in the Lower Aldridge member consist of examples of crossbedding (Plate 1a, and 1b, p.14 ff.). No example of crossbedding was seen on a scale larger than that shown in Plate 1b. Both examples seem to indicate that the current flow was not unidirectional.

The writer at no time was able to observe the contact relations of the Lower and Middle Aldridge members. He understands that the contact is placed at that point where the fine lining of the Lower Aldridge quartzites ceases to exist. This is not a sharp break.

MIDDLE ALDRIDGE MEMBER.

The Middle Aldridge member is estimated to be 10,000 feet thick. This was mapped as rusty and greyish weathering quartzite and argillaceous quartzite. The quartzite greatly predominates over the argillaceous quartzite.

The quartzite of this member lacks the finely lined appearance of the quartzite of the Lower Aldridge member.

The quartzite of the Middle Aldridge member occurs in beds varying in thickness from a very few inches to three and four feet. An occasional bed up to eight feet thick was found. The majority of the quartzite beds were from 6 inches to $1\frac{1}{4}$ feet thick.

In general, the quartzite weathers to a grey color though a rusty weathered appearance is common and is locally dominant.

The quartzites were found to be medium to very fine grained (see p.21).

Quite frequently a close inspection of the rock revealed a high micaceous content of the quartzite.

The individual quartzite beds exhibit extreme uniformity throughout most of their thickness. Very frequently the uniform quartzite beds pass gradationally into a much thinner argillaceous top. Excellent bedding fissility occurs producing a division between the argillaceous top and the overlying quartzite bed. This occurrence results in observable graded bedding (Plate 4a, p.18 ff.). Though quartzite predominates, individual beds consisting mostly of argillaceous quartzite or entirely of argillaceous quartzite are present.

Frequently the argillaceous quartzite proportion has a laminated appearance. This is a consequence of alternate deposition of "sandy" and "muddy" phases.

Primary features of sedimentary deposition are often present in the rocks. Commonly the argillaceous portions of the beds show ripple marks of both the "current ripple mark" type and the "ocsillation ripple mark" type. On occasions good preservation of the oscillation ripple marks enabled the tops of the beds to be determined. Plate 2a (p.17 ff.) illustrates an example of interference wave ripple mark. (Shrock, 1948, and Bucher, 1938). Shrock (1948)

says "Oscillation ripple marks developed in fine argillaceous silt may be so modified by wind action on a thin film of water overlying them that they take the form of "rounded flat-topped blobs not unlike tar creeping on a sloping surface". The oscillation ripple marks of Plate 2a appear to have been modified by wind action.

Crossbedding in the Middle Aldridge member enabled the tops of the beds to be determined. Crossbedding in this member is on a much smaller scale than in the Lower Aldridge member.

Plate 2b (p.17 ff.) shows an example of rill marks formed by receding tidal currents scouring out a system of dendritic channels.

It was not uncommon to see structures that could be interpreted as flow casts. A heavy load of sand lying on soft mud can flow by reason of its water content. This sand molds itself to the underlying mud. If the mud is unequally loaded with sand then ridges and other raised features will be produced and preserved in the overlying sand with its induration. Plate 3b (p.17 ff.) illustrates an example of flow cast whereby the underlying "mud" has been deformed and sharp ridges of it brought up into the overlying sand and preserved there. Another example of penecontemporaneous deformation is shown in Plate 4a (p.18 ff.) where the sand has "squeezed up" the underlying muddy phase.

During the course of the season occasional samples of scour and fill structures were seen. The largest example seen by the writer was a scour with a depth of $2\frac{1}{2}$ inches.

Plate 2.

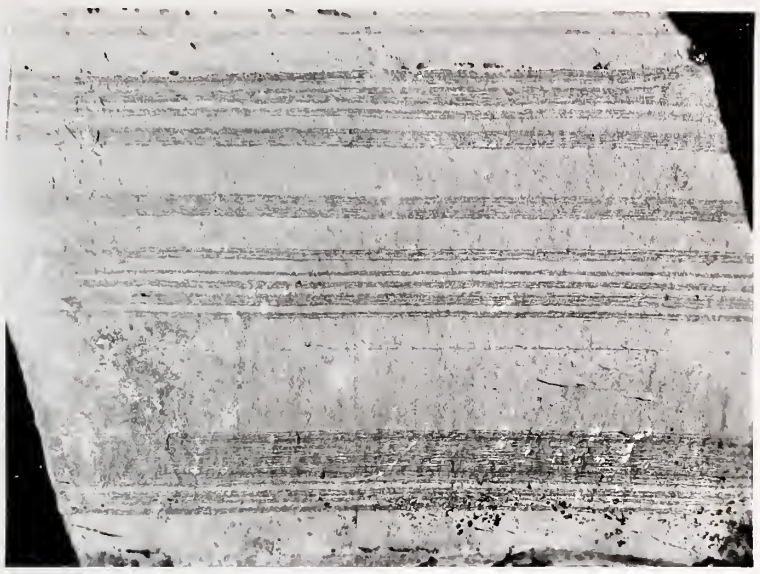
2a. Modified Ripple marks. (1/3 actual size)

Middle Aldridge member; (?)
Wind action on shallow water will modify pre-existing ripple marks and cause them to assume this characteristic form.

2b. Rill marks. (½ actual size)

Middle Aldridge member; (?)
Receding tidal currents will scour out a system of dendritic channels facing seaward. Current flow was from upper left to lower right.

Plate 3.



3a. Laminated argillaceous quartzite. (½ actual size)

Middle Aldridge member;

The very delicate nature of the laminated effect is provided by an accumulation of argillaceous material along the bedding planes.

3b. Penecontemporaneous deformation. (½ actual size)

Middle Aldridge member; (?)
Unequal loading of soft muds by heavy water filled sands will result in a corrugated interface between them. This will result in the sand moving into the mud and parts of the mud layers being "squeezed up" into the sand.

On one occasion the writer observed 5 spheroidal quartzite "balls" with a large diameter no greater than $1\frac{1}{2}$ inches contained between different argillaceous layers. The argillaceous layers were arched around the objects. The writer suspects that they were formed syngenetically.

Intraformational breccias were seen though not extensively developed. The brecciated beds always appear to be those that are more argillaceous in composition. They are recemented by argillaceous material and less commonly by a sandy matrix. Occasionally isolated fragments of breccias were found in massive sandy beds seemingly far removed from any "clay" source. They are always discoid in shape representing an original tabular fragment modified by the transporting water agency.

Near the top of the Middle Aldridge member a zone is present in which a very fine laminated effect is observed. The individual laminae are developed as an expression of argillaceous material laid in a less argillaceous material. The individual laminae are extremely fine and evenly laid out in pattern attesting to the quietness of deposition at this time (Plate 3a, p.17 ff.) This zone is the only horizon in the Middle Aldridge member that gives an observer any indication of where he is in the sedimentary sequence. Incomplete investigation would indicate that it is about 1,000 - 2,000 feet below the top of the Middle Aldridge member.

The Middle Aldridge member is intruded by numberous diorite sills varying in thickness from 25 feet to 900 feet. The writer

Plate 4.

4a. Penecontemporaneous deformation. (1/5 actual size)

Middle Aldridge member;
Graded bedding is also shown in this photograph. The tops of the beds are toward the lower left hand corner.

4b. Bedded quartzite. (photo by Dr. G.B. Leech)

Middle Aldridge;
Large metacrysts of chlorite (?) have been formed in argillaceous beds near a diorite sill (not visible). The quartzite beds remain unaffected.

investigated the possibility of using these sills as horizon markers. An examination along the sills indicated they were wholly unreliable as horizon markers as they continually and unpredictably jumped across the strata. The contact of the diorite and quartzite was found to be very sharp, with the sill showing a very thin chilled margin with no observable effect on the quartzite. The writer observed two instances where the heating effect of the intruding sill caused recrystallization in the more argillaceous parts of the quartzite beds (Plate 4b, p.18 ff.). This effect is more extensively discussed in the section on Petrography.

The uppermost strata of the Middle Aldridge member consist of massive quartzite in beds 6 inches to 1½ feet thick with thin argillaceous partings. This weathers to a greyish and rusty color. This zone passes transitionally through 75 feet into the thinly laminated argillaceous quartzites of the Upper Aldridge member.

UPPER ALDRIDGE MEMBER.

The Upper Aldridge member is estimated to be 1,000 feet thick. It was mapped in the field as rusty weathering finely laminated argillaceous quartzite.

The characteristic rusty weathering color persists throughout the member.

Though locally small amounts of quartzite persist, the member is dominantly argillaceous throughout. The argillaceous quartzite is finely laminated. Quite frequently cavities left by weathered out crystals could be seen. These cavities were never greater than

2 mm. in diameter. Upon breaking the rock the cavities were seen to persist below the surface. Close inspection revealed the presence of very fine pyrite, always associated with much rust. Pyrite has weathered out freeing the iron to form limonite which is the cause of the rusty appearance throughout much of the member.

The writer did not observe any examples of primary features in the Upper Aldridge member.

The Upper Aldridge member passes gradationally into the overlying Creston formation. The rusty weathering, laminated argillaceous quartzites of the Upper Aldridge member pass through a transition zone of 50 feet into the black and dark greenish weathering, finely lined argillaceous quartzites of the overlying Creston formation. There is an appearance of abundant primary features distinguishing this lower part of the Creston formation. No distinct break could be found between the Upper Aldridge member and the Creston formation.

PETROGRAPHY OF THE ALDRIDGE FORMATION

The writer described 45 thin sections from the Aldridge formation. Of this number, 6 were from the Lower Aldridge member, 4 from the Upper Aldridge member and the remaining 35 from the Middle Aldridge member. Standard petrographic blanks were used in this work and are included as Appendix A. The Munsell color chart was used as a standard in describing the color of the hand specimens.

The quartzitic nature of the sediments precluded any determination of the grain size by the commonly recognized methods of sieving. The specimen was considered to have medium grain size if individual grains in the hand specimen could be seen with the naked eye. A specimen of fine grain size did not reveal any individual grains, while a specimen of very fine grain size would be one having a finer "clay like" appearance.

The percentages of the individual minerals were estimated as closely as possible. A figure for the percentage was given for those minerals present in quantities of 1% or greater.

Several separations of heavy minerals were made using the methods described in the section on Laboratory Procedure (p.8). These separates rarely revealed any heavy mineral that could not be found in the corresponding thin section for the specimen used. The accessory minerals were listed in order of abundance. The writer believes that the first two or three minerals listed are correctly placed. When more than three heavy minerals are listed the writer does not maintain that their position in the table correctly reflects their abundance in the thin section. Very often only one or two

examples of one type of heavy mineral were seen in any one thin section.

BASIS OF CLASSIFICATION OF THIN SECTIONS.

A review of various classifications of sedimentary rocks indicated their shortcomings when an attempt was made to use them to classify the thin sections described in this report. The writer has modified Pettijohn's "classification of the arenites based upon the mineral composition of the detrital fraction" (Pettijohn, 1948). This classification utilizes a ternary diagram where three end members of sediments are placed at the three corners of the diagram. This modification was believed necessary in order to eliminate the use of the term greywacke and the tectonic significance its usage implies. This was arrived at by dropping the "Clay" member and substituting an Aluminum Silicate group in its detrital or re-crystallized form. The micas, chlorite,garnet, epidote and kaolin are members of this group. Further modification of the percentage requirements for the groups were carried out.

Figure 1 illustrates the factors involved.

Al. Silicate Group

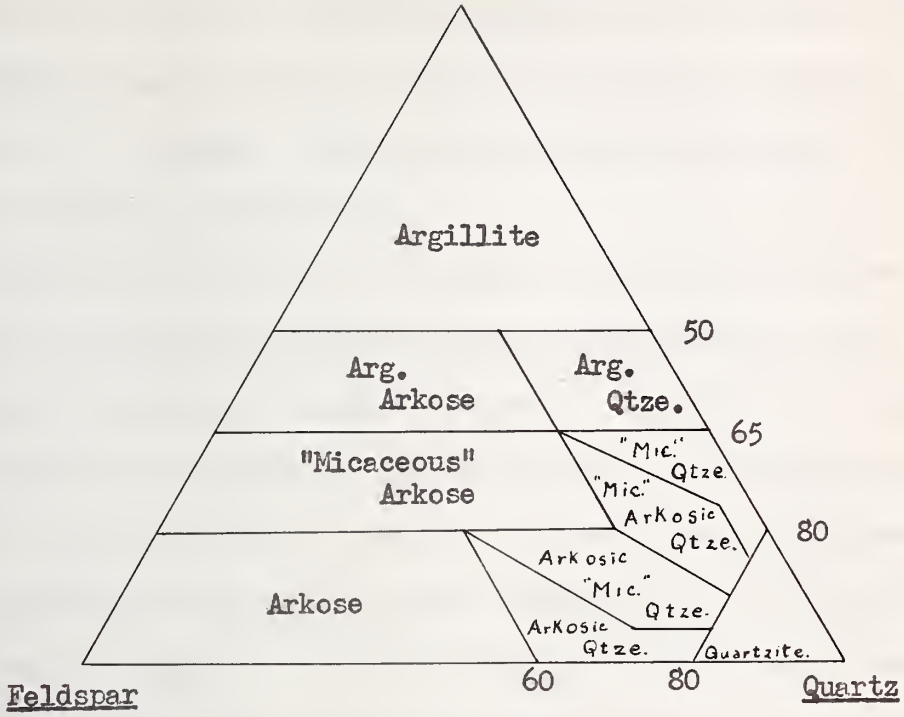


Fig. 1. Classification of the thin sections is based upon this subdivision of the mineral fractions.

This classification does not take into account grain size or source. It is strictly a mineralogical classification designed to cope with the three major constituents in the Aldridge sediments. These three constituents are quartz, feldspar, and members of the aluminum silicate group as specified above.

The requirements for quartzite are lowered from those generally required for quartzite. Any rock with 80% quartz or over is a quartzite in this classification. This was necessary as percentages of minerals other than quartz present precluded a strict definition for quartzite.

An arkose must have 40% feldspar to be considered an arkose in this classification. As this classification is strictly on a quantitative basis it does not take into account the possible source of the feldspar. This is a topic which is discussed later in this section on petrography.

There must be at least 5% feldspar present and 5% of the aluminum silicate group present before these percentages are considered significant enough to be used in the naming of a rock.

The word "micaceous" is used on the chart with some reservation. It is used as an adjective. Its use in "Arkosic micaceous quartzite" would indicate that anywhere from 5 to 20% of the rock could be composed of mica. If the aluminum silicate present was not present as mica but as some other mineral then the name of that mineral would be used as an adjective denoting its presence in the rock. This is exemplified in thin section 50-106 which has 65% quartz, 15% feldspar, 10% chlorite, and 3% mica, and is designated as an "Arkosic chloritic quartzite".

The writer does not contend that this system is perfect. It has served its purpose in providing a system of nomenclature for this particular suite of thin sections which is in accord with general usage.

It was possible to name about 80% of the specimens by direct application of this system.

The specimens sometimes possessed features which seemed significant enough to take into consideration when naming the rock. It was deemed advisable to incorporate the word "schist" when the spec-

imens evidenced distinct schistosity. Similarly, other dominant factors ruled out the usage of the ternary diagram in a few other isolated instances.

CLASSIFICATION OF THIN SECTIONS DESCRIBED

The following table shows the percentage of the three end members and the name given to the rocks.

Slide.	% Qtze.	% Al.S.	% Feld.	Classification
50-13	75	20	--	Micaceous quartzite.
50-14	70	22	--	Micaceous quartzite.
50-15	80	17	--	Quartzite.
50-16	35	30	30	Micaceous arkosic schist.
50-17	55	20	25	Micaceous arkose.
50-92	45	18	35	Arkosic micaceous quartzite.
50-18	35	37	--	Argillaceous quartzite (contains 25% cal-
50-19	30	65	--	Chlorite mica schist. cite)
50-20	40	13	40	Arkosic biotite-muscovite gneiss.
50-21	40	10	45	Arkose.
50-22	45	50	--	Mica schist.
50-23				Micaceous quartzite.
50-24	50	10	35	Arkosic quartzite.
50-98	60	35	--	Argillaceous quartzite.
50-99	80	15	--	Quartzite.
50-100				Micaceous quartzite.
50-101	60	35	--	Argillaceous quartzite
50-104				-- (contains 70% calcite)
50-105	40	31	25	Micaceous arkose.
50-106	65	13	15	Arkosic chloritic quartzite.
50-107	65	14	15	Arkosic micaceous quartzite.
50-108	60	25	10	Micaceous arkosic quartzite.
50-109	50	30	15	Micaceous arkosic quartzite.
50-110	35	40	20	Argillaceous arkose.
50-111	20	45	30	Argillaceous arkose.
50-112	40	25	30	Micaceous arkose.
50-113	50	20	20	Micaceous arkose.
50-114	80	15	--	Quartzite.
50-116	75	20	--	Micaceous quartzite.
50-117	80	15	--	Quartzite.
50-118	40	13	40	Arkose.
50-119	50	45	--	Garnetiferous quartzite.
50-120	65	12	20	Arkosic micaceous quartzite.
50-121	65	30	--	Micaceous quartzite.
50-122	85	10	--	Quartzite.
50-123	55	18	25	Arkosic micaceous quartzite.
50-124	65	17	15	Micaceous arkosic quartzite.
50-125	85	11	--	Quartzite.

Slide.	% Qtze.	% Al.S.	% Feld.	Classification
50-126	70	8	15	Arkosic micaceous quartzite.
50-127	65	7	20	Arkosic chloritic quartzite.
50-128	40	30	25	Micaceous arkose.
50-25				Argillaceous quartzite.
50-27	55	40	--	Micaceous chlorite schist.
50-28	30	65	--	Argillite.
50-29	30	65	--	Argillite.

These percentages are plotted on the following ternary diagram.

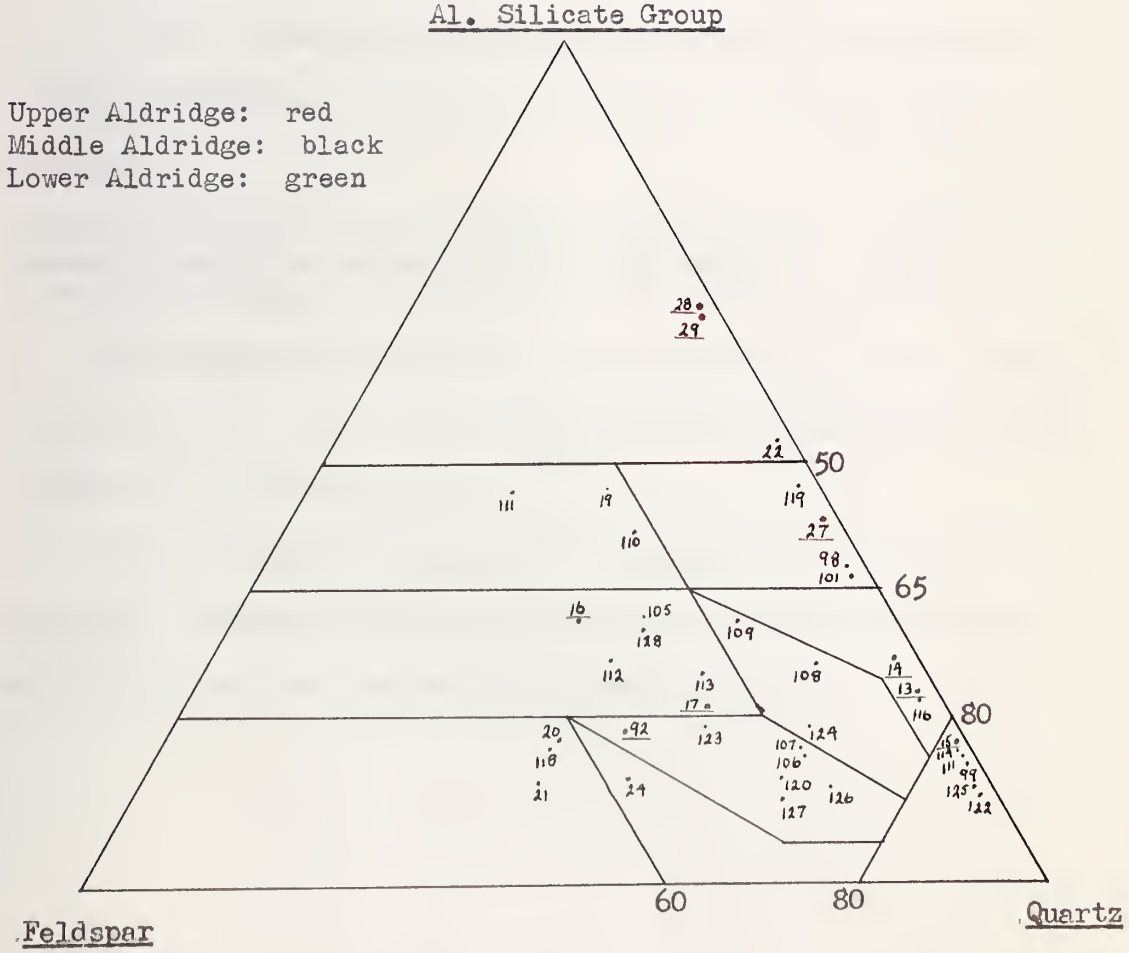


Fig. 2. This diagram shows the mineralogical distribution by percentages of the thin sections studied.

It was not possible to plot all the thin sections on this ternary diagram nor was it possible to name all the specimens from it. The following figures give an estimation of the success this classification gave:

Total number of thin sections studied	45	
Number plotted on Ternary diagram	40	
Number named directly from Ternary diagram	36	80%
Number requiring special names	8	18%
Number unnamed	1	2%
Total:	45	100%

A study of the Ternary diagram reveals the following facts about the percentage of quartz present in the 40 plotted thin sections:

Number of specimens containing 80% or more quartz.	6
Number of specimens containing 50% - 80% quartz.	20
Number of specimens containing under 50% quartz.	14

The diagram does not reveal any concentration of thin sections in any one area. The 40 thin sections plotted have fairly diverse compositional characteristics.

It is worthwhile noting that of the four thin sections from the Upper Aldridge member two of them are classed as argillites while the other two approach this classification.

HEAVY MINERALS.

It was possible to find heavy minerals in every thin section examined.

Heavy mineral separates were made for a number of specimens. These separates did not reveal any heavy mineral which could not be found in the thin section for that specimen.

The following table illustrates the relative abundancy of the various heavy minerals reported:

Number of thin sections 45
Number of times heavy minerals were reported:
apatite.....24
garnet.....13
hematite..... 3
ilmenite..... 8
magnetite.....35
rutile..... 2
tourmaline..... ? (see under tourmaline)
zircon 38

The following minerals commonly considered to be heavy minerals in sediments were reported as metamorphic minerals:

Number of times reported:
garnet 8
zoisite 13

Apatite.

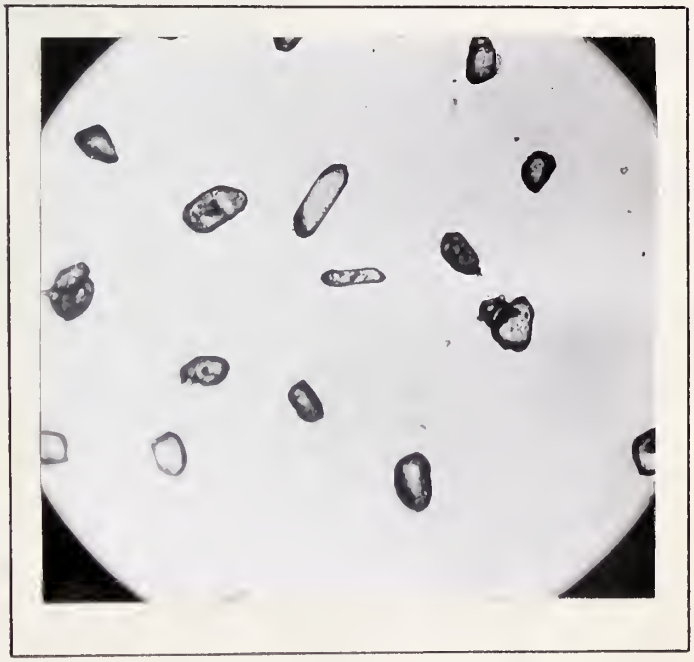
Apatite was found to occur in 24 of the 45 thin sections examined. It occurred as small, well rounded, colorless grains and may, in part, have been introduced with tourmaline.

Garnet.

Garnet appeared to be a detrital mineral in 13 samples. This detrital garnet occurs in small, colorless,well rounded grains.

50-16. Mag. X 40. Tourmaline.

Lower Aldridge member;
Large, elongate, well formed euhedra characterize the introduced tourmaline of the Aldridge formation.



50-17. Mag. X 60. Zircon.

Lower Aldridge member;
The zircons of this specimen have a length/width ratio of 1.6/1.

In addition garnet was considered as a metamorphic development in 8 examples. The characteristic isometric crystal development of this garnet was recognizable in some thin sections. (Photo. 50-100, p.38, ff.). In some instances large single independent garnet metacrysts were developed. Other thin sections showed the development of large porphyroblasts of garnet (Photo. 50-114, p. 37, ff.).

Hematite.

Hematite was noted in three samples only.

Ilmenite and Magnetite.

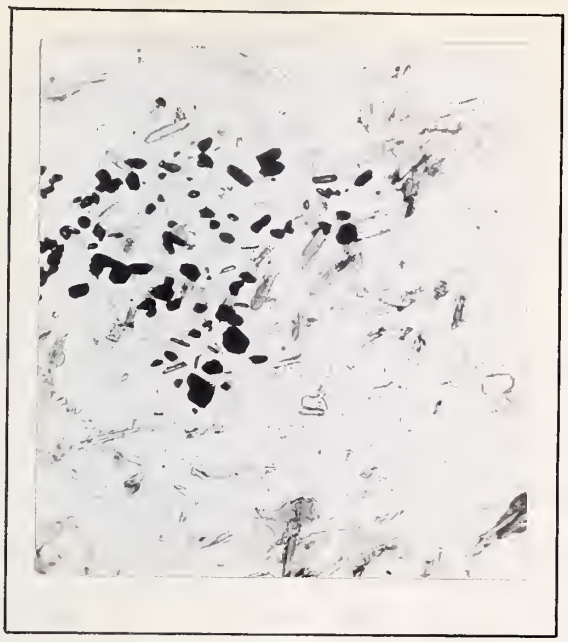
The writer reported magnetite from 35 specimens and ilmenite from 8 specimens. These figures are open to question as it is difficult to distinguish these two minerals in thin sections. It is likely that the 8 specimens were reported correctly as containing ilmenite as, in most instances, the ilmenite was associated with leucoxene. It is not improbable that some of the specimens reported as magnetite may actually be ilmenite. On the basis of testing the heavy mineral separates with a hand magnet, it is the writer's opinion that there is a great preponderance of magnetite over ilmenite (Photo. 50-13, p.29, ff.).

Rutile.

Rutile was reported from only two samples.

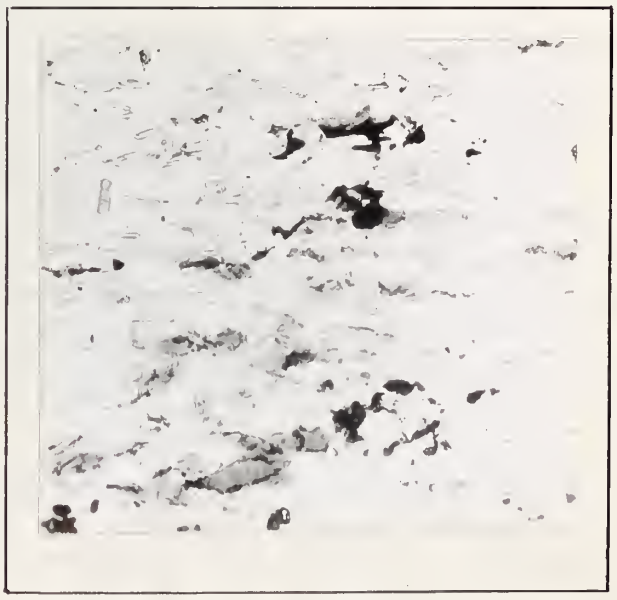
Tourmaline.

Tourmaline was seen to be an introduced mineral in a number of thin sections. This tourmaline is usually more elongate and larger than tourmaline that would normally be considered detrital. Tour-



50-13. Mag. X 60. Micaceous quartzite.

Lower Aldridge member;
Biotite and a localized accumulation of magnetite.
A few grains of rutile are with the magnetite.



50-15 Mag. X 60. Quartzitic schist.

Lower Aldridge member;
The foliate character is due to parallel arrangement of sericite and biotite flakes. Note the tourmaline crystal at an angle of 80 degrees to the schistosity.

maline in the Aldridge formation generally has a fairly good crystal development and its position does not appear to bear any relation to bedding features or schistosity of the rock (Photo. 50-15, p. 29, ff.).

The tourmaline is usually brown in color though frequently color zoning is present. If color zoned, one end of the grain is brown while the other end is light bluish green to colorless. In a number of thin sections the tourmaline grains were small, rounded and lacked any color zoning. In such thin sections they were usually few and possessed no distinctive features to indicate that they were introduced. The writer reported such occurrences as detrital tourmaline, though on the basis of their similar brown color to the introduced tourmaline this "detrital" tourmaline may very well be introduced itself. There is no distinct dividing line apparent between that tourmaline known to be introduced and that smaller amount of indefinite detrital tourmaline.

The proximity of the big zone of replacement tourmaline below the Sullivan ore body near the map area suggests that the tourmaline of the Aldridge formation is for the most part introduced.

Zircon.

Zircon was reported from 38 thin sections studied. It occurs as elongate euhedra showing a small degree of rounding (Photo. 50-17, p. 36, ff.).

A measurement was made on 110 zircons from the heavy mineral separate of this rock. The writer endeavored to measure all types

of zircons seen and to show no partiality toward the well formed euhedra. Those zircons that were obviously broken in the process of making the heavy mineral separate were not measured.

The average length of the zircons was found to be ..... .11 mm.
The average width was found to be ..... .07 mm.
These measurements give a length/breadth ratio: ..... 1.6/1.

This is fairly conclusive proof that the zircon of the Aldridge formation is quite fresh and would certainly be in its first cycle of deposition. These zircons measured were among the largest seen in any of the specimens. Their size does not correctly reflect the size of the zircons as a whole. The shape of these zircons is reflected through the other specimens.

Zoisite.

The writer did not report zoisite as a detrital mineral. It was reported instead as a metamorphic mineral in 13 instances. The zoisite is similar to garnet in the respect that it is developed in the rock in isolated porphyroblasts.

Any interpretation from this suite of heavy minerals must take into account the fact that the actual heavy mineral assemblage is a function of both source rock composition and mineral stability (Pettijohn, 1948).

The stability series as given by Pettijohn is listed below and those minerals found in the Aldridge formation are marked with an asterisk.

Anatase
Muscovite
* Rutile

* Zircon
? Tourmaline
Monazite
* Garnet
Biotite
* Apatite
* Ilmenite
* Magnetite
Staurolite
Kyanite
Epidote
Hornblende
Andalusite
Topaz
Sphene
Zoisite
Augite
Sillimanite
Hypersthene
Diopside
Actinolite
Olivene

Excepting hematite, the heavy minerals reported are the most stable of the stability series. The loss of the less stable heavy minerals detracts from the usefulness to which this heavy mineral suite can be put in interpreting the source rock composition.

Regardless of the limited nature of the heavy mineral suite of the Aldridge formation, it may still be possible to form conclusions from the information left us.

The minerals anatase, rutile, and ilmenite are among the most stable minerals of the stability series. Anatase is absent from the Aldridge formation and ilmenite and rutile are very limited.

These are all titanium bearing minerals and their relative lack may possibly indicate a lack of titanium bearing minerals in the source rocks of these sediments.

The three minerals: zircon, magnetite, and apatite are likely derivatives from a granitic terrain.

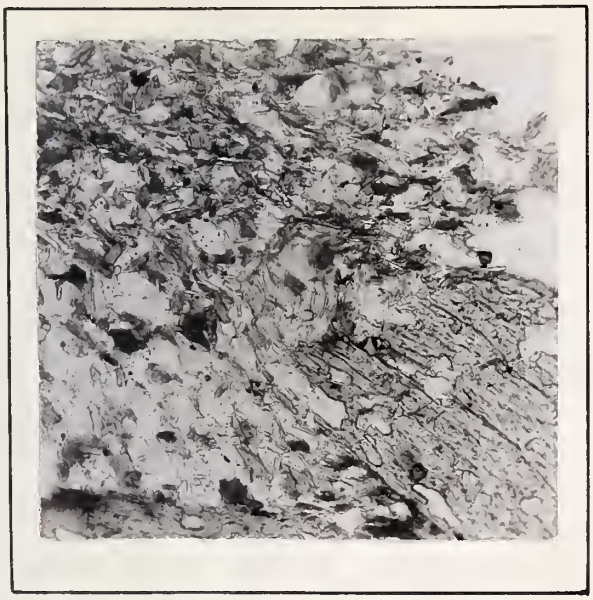
It is not wise to go too far in interpreting the information that the heavy minerals in 45 thin sections provide. These 45 thin sections cannot do more than give a small amount of qualitative information on the nature of the heavy minerals present in the 16,000 feet of Aldridge sediments.

PRIMARY FEATURES SHOWN BY THIN SECTIONS.

The thin sections studied from the Aldridge formation revealed certain characteristics which could only be attributed to environmental conditions existing at the time of deposition of the sediments.

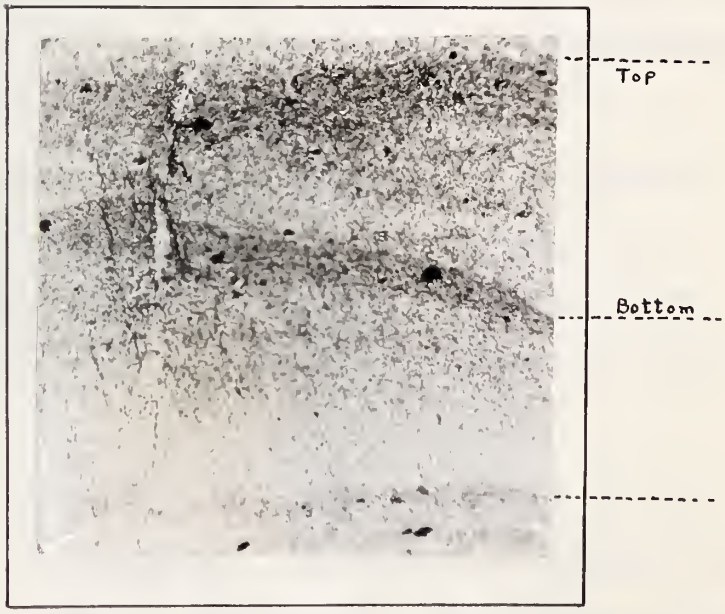
The hand specimens often show a laminated effect. On examining the thin sections it was invariably found that the laminated effect is provided by an expression of biotite in the bedding planes of the rock. In a few instances this laminated effect is accentuated by the accumulation of magnetite in the bedding planes (Photo. 50-108, p. 34, ff.).

A great accumulation of argillaceous material now represented mainly by sericite is instrumental in preserving primary features, particularly in respect to the thin sections from the Upper Aldridge member. An example of graded bedding on a microscopic



50-19. Mag. X 60. Chlorite mica schist.

Middle Aldridge member;
A large metacryst of prochlorite developed by replacement in a background of quartz, sericite and biotite.



50-25. Mag. X 17. Argillaceous quartzite.

Upper Aldridge member;
Graded bedding.
Note the magnetite throughout the rock.

scale was seen in photograph 50-25 (p.33, ff.). The quartzitic portion decreases gradationally into the more argillaceous portion of the slide. This argillaceous portion is in turn marked by a sharp contact with the overlying quartzite laminae.

Crossbedding is well shown in one thin section (50-100). This example was on too large a scale to photograph through the petrographic microscope.

One thin section (Photo. 50-13, p.29,ff.) showed local concentrations of magnetite in the bedding planes of the rock.

METAMORPHISM.

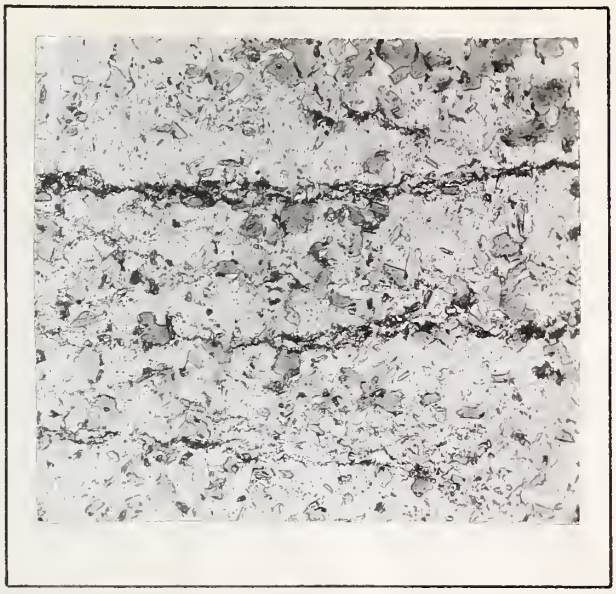
In this section on metamorphism the writer prefers to follow Grout's (1932) division of metamorphism in three types:

a. Contact Metamorphism: This is the change that occurs in the walls of an igneous intrusion as a result of the heat and material emanating from the magmas.

b. Regional Metamorphism: The dominant factor is deep seated deformation with stress, heat, and water playing their part.

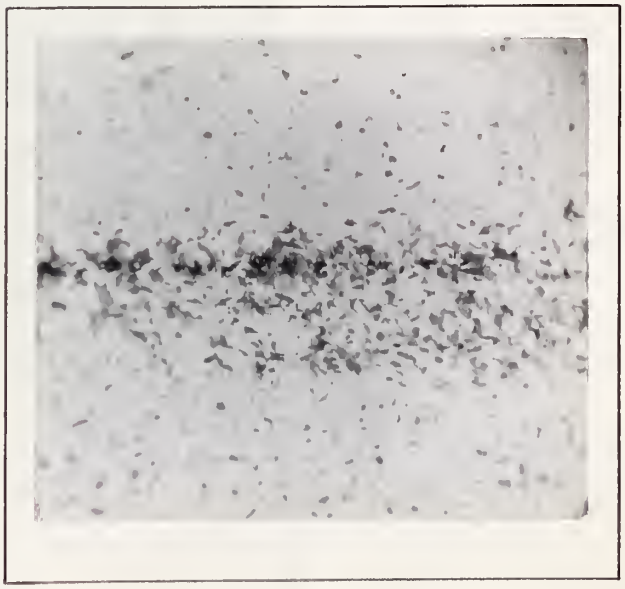
c. Hydrothermal Metamorphism: This is a result of hot water solutions permeating fractures and producing characteristic mineral changes.

The writer observed pertinent facts in the field relating to these three types of metamorphism. Those facts were further investigated in the laboratory in relation to contact metamorphism and regional metamorphism. It was not deemed advisable to investigate the field of hydrothermal metamorphism in this treatise.



50-101. Mag. X 60. Argillaceous quartzite.

Middle Aldridge member;
Lines of "dusty" magnetite give a distinctly laminated appearance.
Note the high percentage (25%) of biotite.



50-108. Mag. X 17. Micaceous arkosic quartzite.

Middle Aldridge member;
A concentration of magnetite and secondary biotite gives a laminated appearance.

Contact Metamorphism.

Contact metamorphic effects were observed in the field in a few instances. In all cases the contact metamorphic action was a consequence of the intruding effect of a diorite sill on the wall rock of quartzite and argillaceous quartzite.

The writer observed the contact of one sill which affected sediments of the Middle Aldridge member up to four to six feet from the edge of the sill. The wall rock consisted of alternate thin bands of quartzite and argillaceous quartzite. The quartzite showed no effect from the intruding action. The argillaceous quartzite had recrystallized producing visible green metacrysts in the rock. A thin section (50-100) revealed that the large metacrysts that had developed through contact metamorphic action were chlorite. This development does not necessarily indicate the introduction of any foreign material though it is likely water was introduced. (Plate 4b, p.18, ff.).

An examination of a "chlorite schist" from the contact of Middle Aldridge sediments with another diorite sill revealed the fact that the chlorite developed was prochlorite (Photo. 50-19, p.33, ff.).

The writer was unable to observe the contact relations of the one granitic stock mapped in the area.

Regional Metamorphism.

Regional metamorphism involves deep burial and deformation factors distributed over prolonged periods of time.

The sediments of the Aldridge formation can certainly satisfy these requirements of deep burial through a prolonged time interval. As a consequence of regional metamorphism quartzite is developed in the place of sandstones and argillites in place of shales. An examination of thin sections revealed evidences of regional metamorphism in all instances.

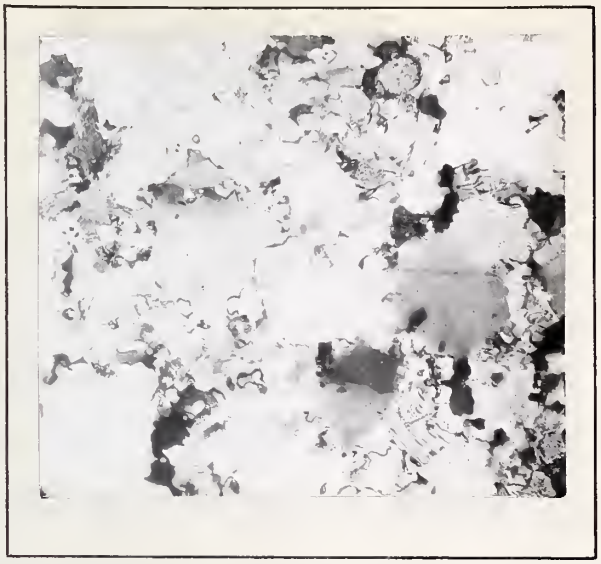
This evidence is exemplified in the typical textures and structures developed. Some thin sections of schistose rocks showed a parallel arrangement of the mica: biotite and muscovite (Photo. 50-15, p. 29, ff.). Such an arrangement is developed to relieve some shearing stress in the rock. The development of biotite and muscovite did not always provide a schistose structure but frequently provided a decussate (crisscross) structure indicating a lack of any shearing stresses.

The quartz grains frequently had a tendency to show undulose extinction: a phenomena attributed to metamorphic stresses.

The sutured mosaic provided the best textural example indicating the effect of regional metamorphism (Photo. 50-17, p. 36,ff.).

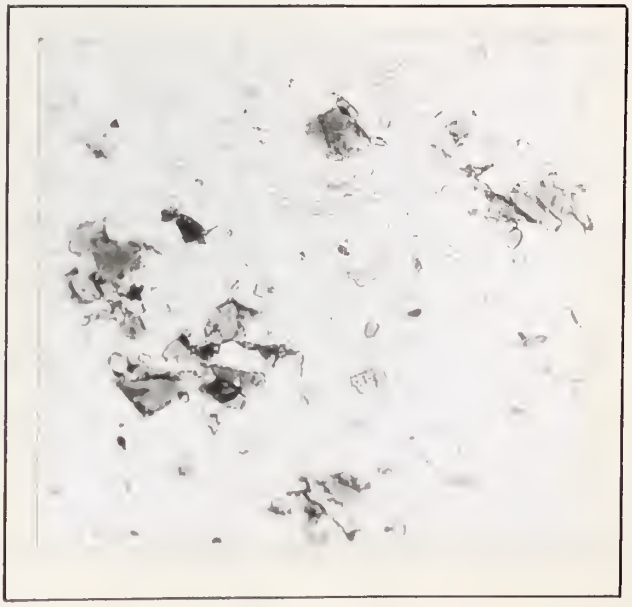
As a corollary to textural and structural evidence the mineralogical changes did much to reveal the history of regional metamorphism.

Harker (1932) lists six progressive stages of regional metamorphism.



50-17. Mag. X 60. Micaceous arkose. (between X nicols)

Lower Aldridge member;
Sutured mosaic texture is well illustrated in this photograph. These quartz grains are the largest seen in 45 thin sections from the Aldridge formation. Note the zircon in the upper right hand corner.



50-92. Mag. X 60. Arkosic micaceous quartzite.

Lower Aldridge member;
Quartz (colorless), biotite (brown), muscovite (colorless laths) and one elongate, fractured tourmaline near the center.

a. Zone of digested clastic mica (Chlorite zone)

b. Biotite zone.

c. Garnet zone.

d. Staurolite zone.

e. Kyanite zone.

f. Sillimanite zone.

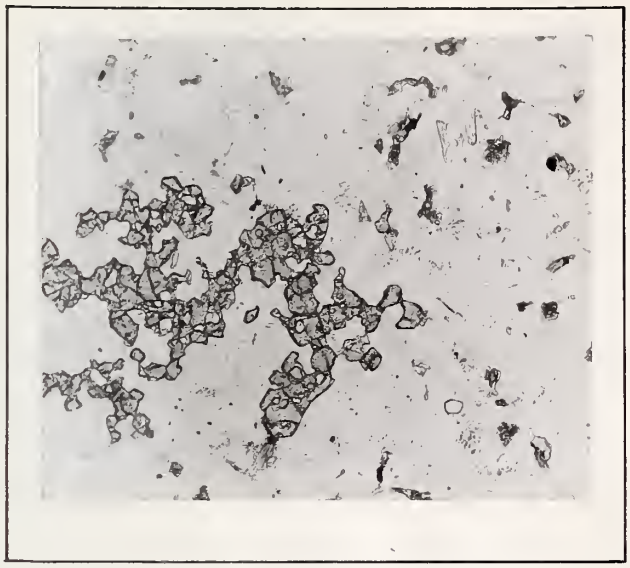
The sediments of the Aldridge formation have been metamorphosed sufficiently to illustrate the chlorite zone and biotite zone. There is some evidence that the garnet zone has been reached (Photo. 50-114, p.37, ff.). Zoisite was seen to occur with the garnet in this zone.

The thin sections examined all showed metamorphic development of either chlorite or biotite. They were found together and singly though there was a greater overall amount of biotite than chlorite seen.

There was a noticeable lack of any minerals from the amphibole, pyroxene, and olivene groups in the thin sections examined. It is possible that minerals of these groups existed in the sediment as fine aggregates when deposited and that their place is now taken by chlorite and biotite.

Muscovite which is present and probably developed with the chlorite could have utilized material from the clays and feldspars for its formation.

The development of the biotite zone marks an accentuation of regional metamorphism. This mineral which is a development from muscovite and chlorite was found to be common. There was no lack



50-114. Mag. X 60. Quartzite.

Middle Aldridge member;
A large porphyroblast of garnet enclosing quartz in poeciloblastic fashion.

of magnetite from which the biotite could draw its iron. The appearance of biotite, like chlorite, is indicative of an argillaceous source rock.

In general, metamorphism of the Aldridge sediments was not seen to progress past the biotite zone. A few specimens did show beginnings of garnet development indicative of yet more profound regional metamorphism.

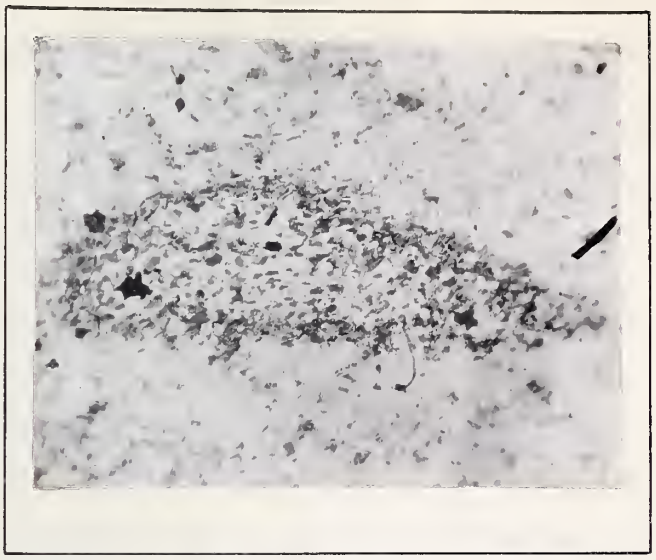
The garnet developed as inclusion metacrysts located in localized concentrations in the rock (Photo. 50-114, p.37, ff.). This garnet may have developed principally at the expense of chlorite which is present in a very small amount. Again, there is no lack of magnetite from which it may draw its iron.

There is not enough evidence to indicate that metamorphism had in general reached the stage where garnet could be considered a characteristic development.

Retrograde Metamorphism.

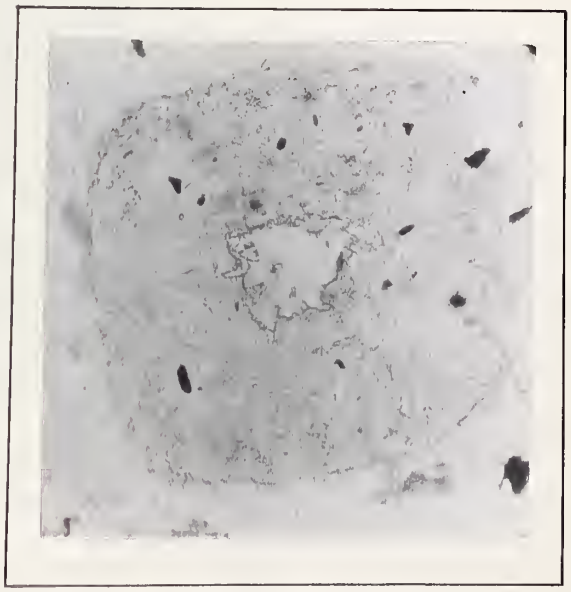
As an antithesis to the progressive sequence of regional metamorphism there were examples of retrograde metamorphism shown in these sediments. Large pseudomorphs of andalusite crystals were developed on one bedding plane observed by the writer. An examination of these revealed that the andalusite had altered to muscovite.

Chlorite pseudomorphs of garnet were seen in one thin section (Photo 50-100, p.38, ff.). The garnet has almost been completely transformed to chlorite which preserved the original isometric shape of the garnet crystal.



50-98. Mag. X 17. Argillaceous quartzite.

Middle Aldridge member;
The shape of a breccia fragment is preserved by the development of biotite.
The opaque mineral inside the biotite on the left is pyrrhotite.



50-100. Mag. X 60. Micaceous quartzite.

Middle Aldridge member;
An example of retrograde metamorphism. A large garnet crystal has been almost completely altered to chlorite. A remnant of the former garnet crystal is seen in the center of the chlorite.

Though limited in quantity these examples are characteristic portrayals of the retrogressive type of metamorphism that occurs as a result of the lessening of the intense regional metamorphic effects. Hydrothermal waters undoubtedly play a part in retrograde metamorphism.

MINERALIZATION.

A study of the thin sections revealed certain facts on mineralization which in quantity and nature make it worthwhile to mention here.

The writer reported the four minerals listed below as being introduced.

Number of thin sections examined.....45
Number of times reported:
Calcite..... 6
Tourmaline.....15
Pyrite..... 1
Pyrrhotite..... 3

There is very little calcite present in four of the thin sections. One thin section has about 25% calcite which was introduced along the bedding planes and in fractures in the rock. The remaining thin section contains 70% calcite. This thin section is not representative of any of the beds. It was taken from an "oily" appearing spheroidal body about 1½ feet long occurring in a massive quartzite bed.

Tourmaline was seen in a number of thin sections but was only listed as being introduced where its nature and relation to the enclosing rock indicated it as such. Where in doubt, the tourmaline was listed as being detrital, though as discussed under the section on heavy minerals, it is very likely that all the tourmaline

was introduced.

Pyrite was only observed in one thin section. Two thin sections from the Upper Aldridge member have large voids filled with limonite which also permeates the adjacent rock. These voids had previously been occupied by pyrite crystals. The pyrite could be seen in the hand specimen for these thin sections.

Pyrrhotite was reported from three thin sections. In one instance it is concentrated along preferred bedding planes. This concentration is along the coarser argillaceous quartzitic bedding planes of an argillite. The pyrrhotite is disseminated through the other two thin sections in which it was seen.

SPECIAL FEATURES.

The writer could have included most of these factors which he discusses here under previous sections. However, he added this section to stress certain factors which he believes are significant and to include those which do not fit easily into the foregoing outline.

The study of the thin sections revealed the presence of feldspar. Some of this was recognized as being plagioclase feldspar. The plagioclase feldspar shows albite twinning, and has a low index of refraction indicating its proximity to the soda end of the albite-anorthite series. It occurs in isolated individual grains which occasionally show a faint suggestion of cleavage. More commonly, the crystal boundary of the feldspar is an irregular outline in the sutured mosaic texture. This feldspar is detrital and is never pres-

ent in more than 2% in any one thin section.

The greatest percentage of feldspar seen consisted of orthoclase. Considerable difficulty was experienced in estimating the relative percentages of orthoclase and quartz in the thin sections. As a result the figures given may contain slight inaccuracies. They serve their purpose in indicating that considerable orthoclase was seen to be present in the sediments.

A study of the orthoclase in these thin sections reveals the fact that it is not often present in single distinct grains. It appears to permeate the rock and to be very subordinate in position to that of the quartz grains. The writer is of the opinion that this orthoclase has, for the most part, come from the recrystallization of detrital feldspar. The tourmaline is known to be largely introduced tourmaline. It is likely that some apatite may be introduced. Thus it is possible that potash may have come in to contribute to the development of the orthoclase.

There is a small amount of orthoclase present which has not undergone recrystallization. This orthoclase is present as large single grains characterized by their individuality. They commonly show a tendency to sericitization.

Some of the larger quartz grains have an ovoid outline suggesting that they had undergone rounding during their transportation and deposition. Nothing definite could be done in this respect as the sutured mosaic texture developed by metamorphism precluded any studies on the rounding of these grains.

THEORETICAL CONSIDERATIONS

SOURCE.

The mineralogical composition of the Aldridge formation is the only means by which the source rocks of the sediments may be determined.

The writer believes the Aldridge sediments to be first cycle deposits. This is shown in two ways:

The percentage of quartz present is not as high as would normally be expected in reworked sediments.

The shape of the zircons, though rounded to a moderate degree in some instances, would in general indicate that they had undergone relatively little transport and could not have passed through a second cycle of erosion.

The elimination of a sedimentary source for these sediments leaves four possible sources which must be considered:

a. Low rank metamorphic rocks.

b. High rank metamorphic rocks.

c. Acid igneous rocks.

d. Basic igneous rocks.

The writer believes the source of the sediments was an acid igneous intrusive. Normal granite consists of 30% quartz, 50% - 60% feldspar, 10% - 20% biotite and muscovite, and small amounts of members from the pyroxene and amphibole groups. These minerals or their derivatives make up the Aldridge formation. The pyroxene and amphibole,if originally present, have been lost through weathering and possible conversion to zoisite. The quartz, detrital

plagioclase feldspar, and small amounts of detrital orthoclase are direct derivatives from the granitic source. The chlorite and biotite present represent recrystallization of the weathered products of similar Fe, Mg, Al silicates present in limited amounts in the granitic source. The heavy residuals, magnetite, apatite, zircon, and ilmenite indicate a granitic source.

The possibility of major contributions from other source rocks to the Aldridge formation can be eliminated by considering those minerals present and the absence of minerals normally produced by different source rocks.

A basic igneous source would lead to larger amounts of ferromagnesium minerals than are found in the Aldridge formation. The stable heavy minerals, anatase and rutile, are almost wholly absent from the sediments yet their presence could be expected if a basic igneous terrain provided the source.

A metamorphic source would give rise to such heavy minerals as garnet, kyanite, sillimanite, and tourmaline. Kyanite and sillimanite are absent from the Aldridge sediments. Garnet and tourmaline do not appear significant as detrital constituents. This evidence tends to eliminate a metamorphic source for the sediments.

It was not possible to make any field observations which definitely indicate the direction from which the sediments came. Previous investigators have indicated their belief that the source of the sediments for the Lower Purcell series lay to the west of the site of deposition. Some of their reasons have since been proven to be

without foundation. No known remnants of any pre-Purcell acidic terrain exist today to the west of the site of deposition. Such terrains were formerly thought to exist but have since been recognized as either Jurassic intrusives or metamorphosed equivalents of the Purcell series such as the Shuswap series (Brock, 1934). Most of the investigators have remarked on the general coarsening of the grain size of the rocks in the western parts of the area. As the writer cannot confirm this he does not exclude a direction other than to the west as a possible source for some of the sediments.

PRODUCTION.

Simultaneous mechanical disintegration and chemical action have been effective in producing the mineralogical components of the Aldridge sediments. The question arises as to which process, mechanical disintegration or chemical breakdown, is dominant.

The writer believes that chemical breakdown has been more effective than mechanical disintegration in producing the sediments of the Aldridge formation. The detrital feldspar is present in very small amounts. Probably most of the feldspar has been lost through chemical attack and alteration to muscovite and kaolin. This fact is substantiated by the development of fine grained mica and chlorite which may be a diagenetic development from kaolin.

Mechanical disintegration implies a high source area and rapid deposition. This leads to the formation of conglomerates which are almost totally lacking in the Aldridge formation.

Continued chemical activity tends to increase the percentage of quartz in sediments. The Aldridge "quartzites" are relatively low in quartz. This fact lends support to the view that mechanical disintegration was effective in the production of the sediments.

The writer prefers to think that chemical action has been the dominant factor in producing the sediments of the Aldridge formation and that mechanical disintegration has been less effective in the production of these sediments.

TRANSPORTATION.

No features were recognizable that definitely indicated any one mode of transport for the sediments of the Aldridge formation. The indurated state of the rock precluded any grain size analysis, and the metamorphic development did not allow any measurements on roundness to be made.

The sediments are waterlain; therefore, it is likely that they are also water transported.

DEPOSITION.

The determination of the environment of deposition of the Aldridge formation is arrived at from limited data. The lack of fossil remains eliminates any environmental approach from that direction. The great age of the sediments and the extent of metamorphism to which they have been subjected also hinders environmental interpretation.

Though there is much similarity throughout the sequence and no unconformities were recognized, there is no reason to believe that

the environmental conditions were the same for the three members of the Aldridge formation. The formation as a whole has certain overall environmental characteristics though each member has certain factors peculiar to itself.

There is abundant evidence of shallow water deposition throughout the Lower and Middle Aldridge members. This is seen in the prevalence of crossbedding in the Lower Aldridge member and in the prevalence of crossbedding, ripple marks, rill marks, and scour and fill structures in the Middle Aldridge member. There were no indications of shallow water deposition in the Upper Aldridge member.

The great thickness of these sediments with their continuous features of shallow water deposition indicate that they have been deposited on a mildly unstable shelf. The only other environments possible are deposition on a stable shelf, in an intracratonic basin or in a geosyncline. (Krumbein, Dapples, Sloss, 1948). Deposition in an intracratonic basin and in a geosyncline would not allow the development of the features of shallow water deposition characteristic of the Lower and Middle Aldridge members. Deposition on a stable shelf does not allow for the accumulation of the great thicknesses of sediments of the Lower and Middle Aldridge members. Thus, only a mildly unstable shelf with an overall negative tendency can allow for the continuous development of shallow water features throughout this great thickness of sediments.

The sediments of the Lower and Middle Aldridge members are not well worted. This also indicates deposition on a mildly unstable shelf rather than on a stable shelf where environmental

conditions acting through a longer period of time effect a higher degree of sorting.

The deposits of a mildly unstable shelf have certain compositional characteristics which are found in the Lower and Middle Aldridge members. The percentage of detrital feldspar, though not high, is to be expected if the sediments were laid on a mildly unstable shelf. The deposits of a mildly unstable shelf contain much clay, silt, and mica. There has been much recrystallization of these finer components of the Lower and Middle Aldridge members. The poor sorting and general fineness of grain size indicates a mixture of clay and silt fractions characteristic of deposition on a mildly unstable shelf.

Aqueous current action which can develop crossbedding is found in rivers and on tidal flats (Kindle, 1917). The crossbedding developed in rivers is a uni-directional development and that developed on tidal flats is a consequence of current action in more than one direction. The crossbedding of the Lower Aldridge member indicates deposition in an environment in which different currents have had their effect on the depositing sands, and is thus a development characteristic of tidal flats. This crossbedding was too universal to be a river development. The lack of current action in a lacustrine environment would not allow the development of crossbedding on the scale observed in the Lower Aldridge member. This feature of crossbedding is the only indication of the deposition of the sediments of the Lower Aldridge member in a marine environment.

There is a limited development of crossbedding in the Middle Aldridge member. Its presence is sufficient only to indicate that current action did exist. The few scour and fill structures seen indicate current action of a fairly vigorous nature.

That the Middle Aldridge member was occasionally exposed to the air during the period of its deposition is shown by the occurrence of intraformational breccias which can develop through the dessication of layers of mud providing angular fragments which become recemented. These intraformational breccias may also develop by wind action on shallow water causing currents that "tear up" the mud layers.

All ripple marks are not evidence of shallow water deposition. However, oscillation type ripple marks with a small wave length as occasionally seen in the Middle Aldridge member, indicate deposition in shallow water. The evidence from ripple marks is too inconclusive to determine whether the sediments were laid in marine or fresh waters.

The graded bedding of the Middle Aldridge member may be a result of turbidity currents (Kuennen and Migliorini, 1950) at depth, or it may represent fluctuation in the source of supply of the sediments. If caused by turbidity currents then the presence of graded bedding with the shallow water features attests to the instability of the shelf area persisting through Middle Aldridge time.

The sediments of the Upper Aldridge member differ in many respects from those of the rest of the formation. The Upper Aldridge sediments contain a higher proportion of argillaceous material and

are more consistently finely laminated. They lack any evidence of shallow water deposition and have the appearances of having been deposited in the deep quiet waters of an intracratonic basin. That they were deposited at depth is shown by the presence of authigenic pyrite indicating reducing conditions. Their higher proportion of argillaceous material is to be expected in the "subgreywacke" sediments of the intracratonic basin. The great amount of interstitial and fragmental material expected in the greywackes of a geosyncline is not recognized in the Upper Aldridge member.

Deposits of intracratonic basins may be laid down in either marine or freshwater environments. There is no evidence indicating deposition of the Upper Aldridge member in only a marine environment or in only a freshwater environment.

A table is given below summarizing the main environmental features of deposition of the three members of the Aldridge formation.

U. Aldridge	Deposition below wave base.	Indeterminate.	Intracratonic basin.
M. Aldridge	Shallow water deposition.	Probably marine.	Mildly unstable shelf.
L. Aldridge	Shallow water deposition.	Marine.	Mildly unstable shelf.

There were no unconformities recognized in the field during the summer of 1950. It is not unlikely that breaks may yet be recognized in this great thickness of sediments.

A conglomerate varying in thickness from 0 feet to 90 feet occurs in the northwest corner of the map area but was not investigated during the field season of 1950. It is known that this conglomerate occurs below the top of the Lower Aldridge member (Swanson, and Gunning, 1945).

The writer was able to obtain a few specimens of this conglomerate from an outcrop on North Star hill. The pebbles of the specimens range in size from a very few fractions of an inch to one and one-half inches in diameter. Four-fifths of the pebbles are argillites and one-fifth are weathered granites. The argillite pebbles represent the disruption of previously existing argillaceous bands.

Roundness determinations were made and it was seen that both the argillite pebbles and granite pebbles fell in Pettijohn's "rounded" class.

Most of the feldspar of the granite pebbles has been removed leaving a porous framework of quartz. It is quite unlikely that the pebbles would withstand transportation in this form. The feldspar has probably been removed by the leaching effect of hydrothermal solutions subsequent to the deposition and induration of the sediments.

The presence of the granite pebbles is significant in strengthening the interpretation that an acid igneous source was present to provide material during the deposition of the Lower Aldridge sediments.

This conglomerate has not been traced for any great distance and is believed to represent deposition in a local basin.

DIAGENESIS.

There is no distinct dividing line marking the division between diagenesis and metamorphism as diagenesis is in actuality the beginning of metamorphism. The physical and chemical changes produced by diagenetic action are masked by a continuation of those same physical and chemical changes under metamorphic action.

It is not possible to attribute any features observed in the thin sections of the Lower and Middle Aldridge members to only the process of diagenesis.

The sediments of the Upper Aldridge member do not appear to have been metamorphosed to the same extent as those of the rest of the formation. The abundant development of fine grained chlorite and sericite in the Upper Aldridge member could be attributed to diagenetic action causing their development from the pre-existing clay minerals.

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APPENDIX.

UNIVERSITY OF ALBERTA

DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

ate Collected
ollector

Specimen No. 50-13.
Locality east end of St.
Reference Mary Lake.

I. FIELD NOTES
Occurrence: Lower Aldridge.
Question:

I. HAND SPECIMEN DESCRIPTION
Color: f.s. light grey, n-7. w.s. moderate brown, 5YR 4/4.
Grain size: fine.
Texture: brown lines give laminated appearance.
Alteration: stained rusty.

I. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: schistose.
Structure: original bedded. secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	75%	kaolin.		biotite.	20%
				zoisite.	
Varietal (x)					
muscovite.					
		GROUNDMASS OR CEMENT		MINERALIZATION	
				tourmaline.	
Accessory (y)					
magnetite.	2%				
apatite.					
rutile.					
zircon. garnet.					

PECIAL FEATURES:

The magnetite occurs in groupings of numerous grains in the bedding planes and is quite abundant. This is closely associated with much biotite.

Quartz is angular, fine-grained, and fairly well sorted. The boundaries of the quartz grains are faintly visible without the use of crossed nicols.

The segregation of the biotite gives the rock its laminated appearance.

The accessory minerals other than magnetite do not appear to have been concentrated.

Vertical fractures are marked by kaolin.

See photograph following page 29.

LASSIFICATION Micaceous quartzite.

PETROGRAPHER
A. Berry.

UNIVERSITY OF ALBERTA

DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-14.
Locality west of St. Mary Lake.
Reference

I. FIELD NOTES

Occurrence: Lower Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. greenish grey, 5G 6/1. w.s. light greenish grey, 5GY 8/1.
Grain size: very fine.
Texture: massive.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: granoblastic.
Structure: original laminated. secondary schistose.

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	70%	kaolin. limonite. leucoxene.		sericite. muscovite. chlorite. zoisite.	20% 2%
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
				tourmaline pyrite. calcite.	1%
Accessory (y)					
ilmenite. magnetite. zircon.	3%				

SPECIAL FEATURES:

Most tourmaline is quite elongate. It is color zoned in that one end is brownish while the other end is bluish-green

The majority of the zoisite has developed in one laminae.

The specimen effervesces lightly in dilute HCl. The carbonate present is probably calcite.

CLASSIFICATION micaceous quartzite.

PETROGRAPHER
A. Berry.

UNIVERSITY OF ALBERTA

DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-15.
Locality White Creek.
Reference

I. FIELD NOTES

Occurrence: Lower Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. very light grey, n-8. w.s. dark yellowish brown, 10YR 4/2.
Grain size: very fine.
Texture: laminated.
Alteration: stained rusty.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: granoblastic.
Structure: original clastic. secondary schistose.

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	80%	chlorite.	2%	sericite.	10%
		kaolin.	1%	biotite.	
		limonite.			
		leucoxene.			
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
				tourmaline.	1%
Accessory (y)					
zircon.					
hematite.					
ilmenite.					
apatite.					

SPECIAL FEATURES:

The schistosity has been developed at an angle of about 35 degrees with the bedding.

The chlorite appears to be secondary to biotite.

There is very little ilmenite left. Most of it has been completely altered to leucoxene.

See photograph following page 29.

CLASSIFICATION Quartzite schist.

PETROGRAPHER
A. Berry.

UNIVERSITY OF ALBERTA

DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-16.
Locality west of St. Mary Lake.
Reference

I. FIELD NOTES
Occurrence: Lower Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION
Color: f.s. light grey, n-7. w.s. dusky brown, 5YR 2/2.
Grain size: very fine.
Texture: schistose.
Alteration: stained.

III. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: ---
Structure: original clastic. secondary schistose.

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	35%	kaolin.		muscovite.	25%
orthoclase.	30%	chlorite.		biotite.	5%
		limonite.		garnet.	
		sericite.			
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
				tourmaline.	1%
Accessory (y)					
magnetite.	1%				
apatite.					
zircon.					
hematite.					

SPECIAL FEATURES:

All elongate minerals are lineated in one direction.

The quartz is quite irregular in size. Many of the quartz grains appear to have been fractured in place, while retaining optical continuity in the rock.

The chlorite has altered from biotite.

The sericite is associated with the feldspar.

See photograph following page 28.

CLASSIFICATION Micaceous arkosic schist.

PETROGRAPHER
A. Berry.

UNIVERSITY OF ALBERTA

DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-17.
Locality Alki Creek.
Reference

I. FIELD NOTES

Occurrence: Lower Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION 5B 7/1.

Color: f.s. light bluish grey, w.s. light olive grey, 5Y 6/1.
Grain size: medium.
Texture: massive.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: sutured mosaic.
Structure: original clastic. secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	55%	chlorite.	5%	muscovite.	10%
orthoclase.	25%	kaolin.			
		leucoxene.			
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
				calcite.	
Accessory (y)					
zircon.					
apatite.					
ilmenite.					
magnetite.					

SPECIAL FEATURES:

The quartz is very irregular in size and shows the sutured contacts very well. It evidences a slight tendancy towards undulose extinction.

The orthoclase appears to have suffered much loss through solution as its position and form is very subordinate to that of the larger quartz grains. The orthoclase contains minute inclusions.

The chlorite is associated with the magnetite and ilmenite.

The quartz and zircon grains seen in this slide are the largest seen in any of the slides examined.

The maximum dimensions of the largest quartz grains were found to be in the order of .5 mm.

The zircons are elongate and well rounded. The longest zircon seen was .15 mm long. Several zircons had a length of .10 mm.

See photograph following page 36.

CLASSIFICATION Micaceous arkose.

PETROGRAPHER
A. Berry.

UNIVERSITY OF ALBERTA

DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-92.
Locality east end of St.
Reference Mary Lake.

I. FIELD NOTES

Occurrence: Lower Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. light grey, n-7. w.s. medium light grey, n-6.
Grain size: fine.
Texture: laminated.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: mosaic.
Structure: original clastic. secondary slightly schistose.

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	45%	kaolin.		muscovite.	10%
orthoclase.	35%			sericite.	
				biotite.	8%
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
				tourmaline.	
Accessory (y)					
zircon.					

SPECIAL FEATURES:

The muscovite and sericite are lined up in the plane of the bedding.

The biotite occurs in definate bedding planes in the rock giving it its laminated appearance.

See photograph following page 36.

CLASSIFICATION Arkosic micaceous quartzite.

PETROGRAPHER
A. Berry.

UNIVERSITY OF ALBERTA

DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-18.
Locality North of St.
Reference Mary Lake.

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. medium grey, n-5. w.s. olive grey, 5Y 4/1.
Grain size: fine.
Texture: laminated.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: ---
Structure: original clastic secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	35%	sericite.	15%	muscovite.	10%
		limonite.	2%	biotite.	10%
		kaolin.	2%	zoisite.	2%
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
				calcite.	25%
Accessory (y)				pyrite.	
magnetite.					
zircon					
tourmaline.					
apatite. garnet.					

SPECIAL FEATURES:

Effervesces strongly in HCl.

The calcite is seen in definate laminae and is also found in zones transecting the laminae.

The quartz is fine grained.

CLASSIFICATION Argillaceous quartzite.

PETROGRAPHER
A. Berry.

UNIVERSITY OF ALBERTA

DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-19.
Locality
Reference Pyramid mountain.

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question: From contact zone of dyke with quartzite.

II. HAND SPECIMEN DESCRIPTION 5G 4/1.

Color: f.s. dark greenish grey, w.s. brownish grey, 5YR 4/1.
Grain size: fine.
Texture: porphyrtic.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: schistose.
Structure: original clastic. secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	30%	limonite.		biotite.	35%
				sericite.	10%
				prochlorite.	20%
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
				tourmaline.	
Accessory (y)					
magnetite.					

SPECIAL FEATURES:

The prochlorite contains an indeterminable small radioactive mineral.

See photograph following page 33.

CLASSIFICATION Chlorite mica schist.

PETROGRAPHER
A. Berry.

UNIVERSITY OF ALBERTA

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-20.
Locality north of St. Mary
Reference Lake.

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. pale red, 5R 6/2. w.s. pale yellowish brown, 10YR 6/2.
Grain size: fine.
Texture: massive.
Alteration: slightly stained.

II. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: mosaic.
Structure: original clastic. secondary gneissic.

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	40%	limonite.		biotite.	8%
orthoclase.	40%	hematite.		muscovite.	5%
Varietal (x)					
plagioclase feldspar.	1%	GROUNDMASS OR CEMENT		MINERALIZATION	
				tourmaline.	
Accessory (y)					
magnetite.	2%				
apatite.					
zircon.					

SPECIAL FEATURES:

The biotite is large, angular, and is localized in the rock.

The quartz and feldspar are quite irregular in size and all is quite angular.

The magnetite shows alteration to hematite.

CLASSIFICATION Arkosic biotite-muscovite gneiss.

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A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-21.
Locality north of St.
Reference Mary Lake.

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. pale blue, 5PB 7/2. w.s. light olive grey, 5Y 6/1.
Grain size: very fine.
Texture: massive.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: granular.
Structure: original clastic. secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	40%	leucoxene.		biotite.	5%
orthoclase.	45%	chlorite.			
		hematite.			
Varietal (x)		sericite.	5%		
		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)					
ilmenite.					
zircon.					
apatite.					
garnet.					

SPECIAL FEATURES:

The orthoclase is extremely fine grained.

The chlorite. appears to have been altered from biotite.

There is slight evidence of a radioactive mineral associated with a few grains of biotite and chlorite.

CLASSIFICATION Arkose.

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A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-22.
Locality north of St. Mary
Reference Lake.

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. light olive grey, 5Y 6/1 w.s. olive grey, 5Y 4/1.
Grain size: fine.
Texture: laminated.
Alteration: stained rusty.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: granular.
Structure: original clastic. secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	45%	chlorite.	15%	biotite.	20%
		limonite.		garnet.	
Varietal (x)					
sericite.	15%	GROUNDMASS OR CEMENT		MINERALIZATION	
				tourmaline.	
Accessory (y)					
magnetite.					
apatite					

SPECIAL FEATURES:

Most of the elongate minerals are lined up.

A radioactive mineral is contained in the chlorite.

The garnets have grown to a fairly large size.

CLASSIFICATION Mica schist.

PETROGRAPHER
A Berry.

UNIVERSITY OF ALBERTA

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-23.
Locality north of St.
Reference Mary Lake.

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION 5Y 6/1.

Color: f.s. light olive grey, w.s. olive grey, 5Y 4/1.
Grain size: fine.
Texture: laminated.
Alteration: stained.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: granular.
Structure: original clastic. secondary ---

PRIMARY MINERALS %	SECONDARY MINERALS %	METAMORPHIC MINERALS %
Essential quartz.	Alteration products (z) limonite. kaolin. chlorite.	biotite. muscovite. garnet.
Varietal (x)	GROUNDMASS OR CEMENT	MINERALIZATION
Accessory (y) magnetite. 2% tourmaline.		

SPECIAL FEATURES:

This thin section illustrates an example of retrograde metamorphism.

The hand specimen contains large crystals which are pseudomorphs of andalusite crystals. On examining the thin section it is seen that these large crystal structures are composed entirely of muscovite.

The magnetite is as prolific in the muscovite fraction as in the quartzite fraction.

The garnet shows alteration to chlorite.

CLASSIFICATION Micaceous quartzite.

PETROGRAPHER A. Derry.

UNIVERSITY OF ALBERTA

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-24.
Locality north of St. Mary Lake.
Reference

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. medium light grey, n-6. w.s. olive grey, 5Y 4/1.
Grain size: fine.
Texture: massive.
Alteration: stained.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: granular.
Structure: original clastic. secondary sutured mosaic.

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	50%	kaolin.		biotite.	10%
orthoclase.	35%	sericite.		muscovite.	
		leucoxene.			
Varietal (x)					
plagioclase feldspar.	1%	GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)					
ilmenite.	1%				
garnet.					
zircon.					

SPECIAL FEATURES:

The quartz is of unequal size and quite angular.

The garnets and zircons are well rounded.

CLASSIFICATION Arkosic quartzite.

PETROGRAPHER
A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-98.
Locality Alki Creek.
Reference

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. medium dark grey, n-4 w.s. medium light grey. n-6
Grain size: very fine.
Texture: this is a cemented breccia.
Alteration: none visible.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: granular.
Structure: original clastic. secondary

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	60%	chlorite. kaolin. limonite.		sericite. biotite.	25% 10%
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
				pyrrhotite. tourmaline.	
Accessory (y) zircon. apatite.					

SPECIAL FEATURES:

MEGASCOPICALLY--- This is a breccia without a high incidence of brecciated fragments. It is an intraformational breccia.

MICROSCOPICALLY--- The thin section cuts across a brecciated fragment. The outline of this fragment is marked by a high incidence of biotite with a lesser amount of biotite contained within the center of the fragment.

The quartz is very uneven in size.

See photograph following page 38.

CLASSIFICATION Argillaceous quartzite.

PETROGRAPHER
A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-99.
Locality Pyramid Creek.
Reference

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION 5B 7/1

Color: f.s. light bluish grey, w.s. moderate yellowish brown, 10YR 5/4
Grain size: fine.
Texture: massive.
Alteration: stained.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: granular.
Structure: original clastic. secondary sutured mosaic.

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	80%	kaolin. chlorite. limonite.		sericite. biotite. zoisite.	15%
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y) zircon apatite.					

SPECIAL FEATURES:

The quartz is very irregular in size and is quite angular.

CLASSIFICATION Quartzite.

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A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-100.
Locality Pyramid Creek.
Reference

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question: This specimen is from the contact zone of a diorite sill with quartzite. (within 4 feet)

II. HAND SPECIMEN DESCRIPTION

Color: f.s. w.s. dark greenish grey, 5GY 4/1.
Grain size: very fine.
Texture: banded, (crossbedding seen).
Alteration: ---

f.s. light bluish grey, 5B 7/1.
f.s. dark greenish grey, 5GY 4/1.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: granular.
Structure: original clastic, (crossbedded) secondary There appears to be recrystallization of the argillaceous part of the slide.

PRIMARY MINERALS %	SECONDARY MINERALS %	METAMORPHIC MINERALS %
Essential quartz.	Alteration products (z)	biotite. sericite. garnet. chlorite.
Varietal (x)	GROUNDMASS OR CEMENT	MINERALIZATION
Accessory (y) magnetite. zircon.		tourmaline.

SPECIAL FEATURES:

A radioactive mineral is evident in some of the chlorite and biotite.

The quartzite bands are units in themselves as evidenced by self contained crossbedding. The laminae showing crossbedding are characterized by the presence of biotite.

There is some evidence that the garnet is altering to chlorite. It is possible to find chlorite (without associated garnet) pseudomorphs of garnet. Most of the chlorite is present as large metacrysts.

Most of the garnet and chlorite has developed in the argillaceous portion of the slide. This is the portion containing the majority of the mica.

See photograph following page 38.

CLASSIFICATION Micaceous quartzite.

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A. Berry.

UNIVERSITY OF ALBERTA

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-101.
Locality Pyramid Creek.
Reference

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. medium dark grey, n-4. w.s. medium grey, n-5.
Grain size: very fine.
Texture: faintly laminated.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: granular.
Structure: original clastic, secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	60%	kaolin	2%	biotite.	25%
				sericite.	10%
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
				tourmaline	
Accessory (y)					
magnetite.					
garnet.					
zircon.					

SPECIAL FEATURES:

The quartz is very fine-grained.

The laminated appearance is marked by lines of "dusty", fine-grained magnetite.

See photograph following page 34.

CLASSIFICATION Argillaceous quartzite.

PETROGRAPHER
A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-104.
Locality Alki Creek.
Reference

I. FIELD NOTES
Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION
Color: f.s. yellowish grey, 5Y 8/1. w.s. brownish grey, 5YR 4/1.
Grain size: fine.
Texture: Differential weathering leaves laminae.
Alteration:

III. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: granular.
Structure: original clastic. secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	15%	limonite.		zoisite.	
				muscovite.	10%
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
				calcite.	70%
Accessory (y)				pyrrhotite.	
magnetite.					

SPECIAL FEATURES:

This specimen is not typical of the bed in which it was found. This specimen was taken from a nodular, oily looking, spheroidal body about 1½ feet long in a massive quartzite bed.

The thin section shows a relict crystal structure filled with muscovite. This form appears to be a relict form of an andalusite crystal.

The calcite is introduced.

CLASSIFICATION -----

PETROGRAPHER A. Berry.

UNIVERSITY OF ALBERTA

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-105.
Locality Alki Creek.
Reference

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. medium light grey, n-6.w.s. light olive grey, 5Y 6/1.
Grain size: fine.
Texture: massive.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: sutured mosaic.
Structure: original clastic. secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	40%	limonite.		biotite.	8%
orthoclase.	25%	kaolin.		muscovite.	15%
				chlorite.	8%
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)					
magnetite.	1%				
zircon.					
apatite.					

SPECIAL FEATURES:

Some of the chlorite is altering to limonite.

CLASSIFICATION Micaceous arkose.

PETROGRAPHER
A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-106.
Locality Alki Creek.
Reference

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. medium dark grey, n-4. w.s. olive grey, 5Y 6/1.
Grain size: fine.
Texture: massive.
Alteration: stained along cracks.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: ---
Structure: original clastic. secondary granoblastic.

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	65%	chlorite.	10%	biotite.	3%
orthoclase.	15%	limonite.	2%	muscovite.	
		kaolin.			
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
				calcite.	
Accessory (y)					
magnetite.	1%				
zircon.					
garnet.					
apatite.					

SPECIAL FEATURES:

Some of the larger quartz grains are rounded.

The, garnet, apatite, and zircon, are well rounded.

Much of the chlorite is associated with magnetite.

CLASSIFICATION Arkosic chloritic quartzite.

PETROGRAPHER
A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-107.
Locality Alki Creek.
Reference

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. light grey, n-7. w.s. light olive grey, 5Y 6/1.
Grain size: fine.
Texture: massive.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: granular.
Structure: original clastic. secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	65%	chlorite.	2%	muscovite.	10%
orthoclase.	15%	limonite.	2%	biotite.	2%
		kaolin.		zoisite.	
Varietal (x)					
Plagioclase feldspar.	1%	GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)					
magnetite.					
zircon.					
apatite.					

SPECIAL FEATURES:

The orthoclase contains many minute inclusions arranged parallel to the cleavage. There appears to be much fine grained orthoclase associated with the muscovite. Thus the muscovite has probably developed from the orthoclase.

CLASSIFICATION Arkosic micaceous quartzite.

PETROGRAPHER
A. Berry.

UNIVERSITY OF ALBERTA

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-108.
Locality Alki Creek.
Reference

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. medium light grey, n-6.w.s. moderate brown, 5YR 3/4.
Grain size: very fine.
Texture: laminated.
Alteration: There appears to be a recrystallization of the dark upper part of each bed.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: ---
Structure: original clastic. secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	60%	kaolin.		biotite.	15%
orthoclase.	10%	sericite.	10%		
Varietal (x)					
plagioclase feldspar	1%				
		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)					
magnetite.					
zircon.					
apatite.					
tourmaline. rutile.					

SPECIAL FEATURES:

The orthoclase may be introduced material. Evidence as to its clastic nature is indeterminable. It is very fine grained.

The tourmaline appears to be detrital.

The laminated effect is provided by the accumulation of biotite into layers.

Much magnetite is present with one layer of biotite.

See photograph following page 34.

CLASSIFICATION Micaceous arkosic quartzite.

PETROGRAPHER
A. Berry.

UNIVERSITY OF ALBERTA

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-109.
Locality Alki Creek.
Reference

I. FIELD NOTES
Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION
Color: f.s. medium grey, n-5. w.s. greenish grey, 5Gy 6/1.
Grain size: very fine.
Texture: few fine laminae.
Alteration: There appears to be a certain amount of recrystallization.

III. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: ---
Structure: original clastic, (laminated) secondary --

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	50%	kaolin.		biotite.	20%
orthoclase.	15%	sericite.	10%		
Varietal (x)					
Plagioclase feldspar.	1%	GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)					
magnetite.					
zircon.					
apatite.					
tourmaline.					

SPECIAL FEATURES:

The orthoclase is very fine grained and could possibly be introduced.

CLASSIFICATION Micaceous arkosic quartzite.

PETROGRAPHER
A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-110.
Locality Alki Creek.
Reference

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. medium grey, n-5. w.s. light olive grey, 5Y 6/1.
Grain size: very fine.
Texture: laminated.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: ---
Structure: original clastic, (laminated) secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	35%	sericite.	15%	biotite.	25%
orthoclase.	20%	limonite.			
		kaolin.			
Varietal (x)		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)					
magnetite.					
zircon.					
tourmaline.					
apatite. garnet.					

SPECIAL FEATURES:

Some of the larger quartz grains show rounding.

The laminated effect is provided by the accumulation of biotite in layers.

CLASSIFICATION Argillaceous arkose.

PETROGRAPHER
A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-111.
Locality Alki Creek.
Reference

I. FIELD NOTES
Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION
Color: f.s. medium light grey, n-6. w.s. medium grey, n-7.
Grain size: very fine.
Texture: laminated.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: ---
Structure: original graded bedding seen. secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	20%	sericite.	35%	biotite.	10%
orthoclase.	30%	chlorite.			
		kaolin.			
Varietal (x)		limonite.			
		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)					
magnetite.	1%				
apatite.					
garnet.					
tourmaline.					

SPECIAL FEATURES:

The quartz and orthoclase are predominant in some bands. This decreases gradationally in quantity into bands consisting mainly of sericite.

Some fractures cutting across the bedding are filled with quartz and chlorite.

CLASSIFICATION Argillaceous arkose.

PETROGRAPHER
A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-112.
Locality Alki Creek.
Reference

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. medium light grey, n-6.w.s. dark yellowish brown,
Grain size: very fine.
Texture: massive.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: granular.
Structure: original clastic. secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	40%	sericite.	5%	biotite.	20%
orthoclase.	30%	kaolin.			
		limonite.			
Varietal (x)					
plagioclase, feldspar.	2%	GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)					
zircon.					
tourmaline.					
garnet. magnetite.					
apatite. hematite.					

SPECIAL FEATURES:

A great variation in the size of the quartz grains is evident.

CLASSIFICATION Micaceous arkose.

PETROGRAPHER
A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-113.
Locality Alki Creek.
Reference

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. medium light grey, n-6. w.s. greyish brown, 5YR 3/2.
Grain size: fine.
Texture: massive.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: sutured mosaic.
Structure: original clastic. secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	50%	kaolin.		biotite.	15%
orthoclase.	20%	chlorite.		zoisite.	
		limonite.		muscovite.	
Varietal (x)		sericite.	5%		
plagioclase feldspar.	1%				
		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)					
magnetite.					
tourmaline.					
zircon.					
garnet. apatite.					

SPECIAL FEATURES:

Some chlorite has altered from biotite.

CLASSIFICATION

Micaceous arkose..

PETROGRAPHER
A. Berry.

UNIVERSITY OF ALBERTA

DEPARTMENT OF GEOLOGY AND MINERALOGY

PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-114.
Locality Alki Creek.
Reference

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. light grey, n-7. w.s. light olive grey, 5Y 4/1.
Grain size: fine.
Texture: massive.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: sutured mosaic.
Structure: original clastic. secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	80%	kaolin.	10%	biotite.	
		limonite.		muscovite.	
		chlorite.		zoisite.	2%
				garnet.	3%
Varietal (x)					
orthoclase.		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)					
magnetite.					
zircon.					

SPECIAL FEATURES:

The garnet has developed in the rock in large groupings.

See photograph following page 37.

CLASSIFICATION Quartzite.

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A. Berry.

UNIVERSITY OF ALBERTA

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-116.
Locality Alki Creek.
Reference

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. light grey, n-6. w.s. moderate brown, 5YR 3/4.
Grain size: very fine.
Texture: massive.
Alteration: heavily stained.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: sutured mosaic.
Structure: original clastic. secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	75%	kaolin. limonite. chlorite.		biotite.	10%
Varietal (x)					
sericite.	10%	GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y) magnetite. zircon. tourmaline. garnet.					

SPECIAL FEATURES:

The quartz is very uneven in size. The larger grains show fair to good rounding. The small quartz grains are quite angular.

The limonite is grouped in distinctive areas. Some of the limonite appears to have altered from chlorite.

CLASSIFICATION Micaceous quartzite.

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A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-117.
Locality Alki Creek.
Reference

I. FIELD NOTES
Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION
Color: f.s. medium light grey, n-6. w.s. greyish brown, 5YR 3/2.
Grain size: very fine.
Texture: massive.
Alteration: stained.

III. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: granular.
Structure: original clastic. secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	80%	limonite.	5%	biotite.	10%
		kaolin.			
Varietal (x)					
sericite.	2%	GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)					
zircon.					
tourmaline.					
magnetite.					

SPECIAL FEATURES:

The quartz grains are very irregular in size. The larger grains suggest rounding to a certain extent.

There is a wide banding effect caused by an accumulation of kaolin, magnetite, small quartz grains, and lineation of the mica.

CLASSIFICATION Quartzite.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-118.
Locality Alki Creek.
Reference

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. light grey, n-7. w.s. light olive grey, 5Y 6/1.
Grain size: fine.
Texture: massive.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: sutured mosaic.
Structure: original granular. secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	40%	chlorite.	5%	muscovite.	8%
orthoclase.	40%	kaolin.		zoisite.	
		sericite.			
Varietal (x)		limonite.			
plagioclase feldspar.		leucoxene.			
		GROUNDMASS OR CEMENT		MINERALIZATION	
				tourmaline.	
Accessory (y)					
ilmenite.					
zircon.					
garnet.					

SPECIAL FEATURES:

The chlorite shows alteration to limonite.

A small radioactive mineral is visible in some of the chlorite.

Some of the larger quartz grains show a small amount of rounding.

CLASSIFICATION Arkose.

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A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-119.
Locality Alki Creek.
Reference

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question: (This specimen is from a 7 inch bed of massive quartzite showing recrystallization of coarser constituents.)

II. HAND SPECIMEN DESCRIPTION

Color: f.s. light grey, n-7. w.s. very light grey, n-8.
Grain size: very fine.
Texture: porphyritic.
Alteration:

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: ---
Structure: original clastic. secondary groupings of recrystallized minerals visibl

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	50%	kaolin.	10%	garnet.	20%
		limonite.		zoisite.	5%
				chlorite.	10%
Varietal (x)					
muscovite.					
		GROUNDMASS OR CEMENT		MINERALIZATION	
				calcite.	
Accessory (y)					
zircon.					
apatite.					

SPECIAL FEATURES:

There is some rounding of the larger quartz grains.

The garnet and the zoisite occur in individual groupings.

CLASSIFICATION Garnetiferous quartzite.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-120.
Locality Alki Creek.
Reference

I. FIELD NOTES
Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION
Color: f.s. medium light grey, n-6. w.s. light olive grey, 5Y 6/1.
Grain size: fine.
Texture: massive.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: sutured mosaic.
Structure: original clastic. secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	65%	chlorite.		muscovite.	2%
orthoclase.	20%	limonite.		biotite.	10%
Varietal (x)					
plagioclase feldspar.					
		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)					
magnetite.	2%				
zircon.					
tourmaline.					

SPECIAL FEATURES:

Some of the large quartz grains show rounding.

This slide may possibly show that the orthoclase is authigenic as its position appears to be subordinate to that of the larger quartz grains.

CLASSIFICATION Arkosic micaceous quartzite.

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A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-121.
Locality Alki Creek.
Reference

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. medium light grey, n-6. w.s. brownish black. 5YR 2/1.
Grain size: very fine.
Texture: laminated.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: granular.
Structure: original clastic, (laminated) secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	65%	chlorite. kaolin.		biotite.	20%
Varietal (x)					
sericite.	10%	GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y) tourmaline. zircon. magnetite. garnet.					

SPECIAL FEATURES:

There is some lineation of the sericite.

The accumulation of biotite in layers provides the laminated effect.

CLASSIFICATION Micaceous quartzite.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-122.
Locality Alki Creek.
Reference

I. FIELD NOTES
Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION
Color: f.s. light grey, n-7. w.s. yellowish grey, 5Y 7/2.
Grain size: fine.
Texture: massive.
Alteration: localized 'rusty' spots.

III. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: sutured mosaic.
Structure: original clastic. secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	85%	chlorite.	5%	muscovite.	5%
		limonite.	2%	zoisite.	
		kaolin.		garnet.	
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)					
magnetite.	1%				
zircon.					
apatite.					

SPECIAL FEATURES:

The limonite appears to have altered from chlorite.

Garnet porphyroblasts have developed.

CLASSIFICATION Quartzite.

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A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-123.
Locality Alki Creek.
Reference

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. yellowish grey, 5Y 8/1. w.s. yellowish grey, 5Y 8/1.
Grain size: medium.
Texture: massive.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: sutured mosaic.
Structure: original clastic. secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	55%	chlorite.	8%	muscovite.	10%
orthoclase.	25%	limonite.		biotite.	
Varietal (x)					
plagioclase feldspar.		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)					
magnetite.					
zircon.					
apatite.					

SPECIAL FEATURES:

The limonite appears to have been altered from chlorite.

The orthoclase in this thin section appears to be very subordinate in position to the quartz grains. The orthoclase appears to have "grown" in place.

CLASSIFICATION Arkosic micaceous quartzite.

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A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-124.
Locality Alki Creek.
Reference

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. medium grey, n-5. w.s. yellowish grey, 5Y 7/2.
Grain size: very fine.
Texture: massive.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: sutured mosaic.
Structure: original clastic. secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	65%	chlorite.	4%	biotite.	8%
orthoclase.	15%	kaolin.		muscovite.	5%
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)					
zircon.					
magnetite.					
apatite.					
tourmaline.					

SPECIAL FEATURES:

The limonite appears to have altered from chlorite.

CLASSIFICATION Micaceous arkosic quartzite.

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A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-125.
Locality Alki Creek.
Reference

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. light grey, n-7. w.s. light olive grey, 5Y 6/1.
Grain size: medium.
Texture: massive.
Alteration: small redish 'garnetiferous' zones present.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: sutured mosaic.
Structure: original clastic. secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	85%	kaolin.	5%	garnet.	4%
		limonite.		zoisite.	
		chlorite.		muscovite.	2%
		leucoxene.			
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)					
zircon.					
ilmenite.					

SPECIAL FEATURES:

The garnet has developed in localized areas.

CLASSIFICATION Quartzite.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-126.
Locality Alki Creek.
Reference

I. FIELD NOTES
Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION
Color: f.s. very light grey, n-7. w.s. light olive grey, 5Y 6/1.
Grain size: fine.
Texture: massive.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture: sutured mosaic.
Structure: original clastic. secondary ----

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	70%	chlorite.	3%	muscovite.	5%
orthoclase.	15%	kaolin.	3%		
		limonite.	1%		
Varietal (x)					
plagioclase feldspar.		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)					
magnetite.	1%				
zircon.					
apatite.					

SPECIAL FEATURES:

CLASSIFICATION Arkosic micaceous quartzite.

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A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-127.
Locality Alki Creek.
Reference

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION 10YR 6/2.

Color: f.s. pale yellowish brown, w.s. yellowish grey, 5Y 7/2.
Grain size: fine.
Texture: massive.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: granular.
Structure: original clastic. secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	65%	chlorite.	5%	muscovite.	2%
orthoclase.	20%	limonite.	2%	zoisite.	
		leucoxene.			
		kaolin.			
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)					
magnetite.					
ilmenite.					
zircon.					

SPECIAL FEATURES:

The chlorite shows alteration to limonite.

CLASSIFICATION Arkosic chloritic quartzite.

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A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-128.
Locality Alki Creek.
Reference

I. FIELD NOTES

Occurrence: Middle Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. light grey, n-7. w.s. moderate brown, 5YR 3/4.
Grain size: very fine.
Texture: laminated.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: granular.
Structure: original clastic, (laminated) secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	40%	sericite.	5%	biotite.	25%
orthoclase.	25%	chlorite.			
Varietal (x)					
plagioclase feldspar.		GROUNDMASS OR CEMENT		MINERALIZATION	
Accessory (y)					
zircon.					
tourmaline.					

SPECIAL FEATURES:

The laminae are marked by an expression of biotite.

CLASSIFICATION Micaceous arkose.

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UNIVERSITY OF ALBERTA

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-25.
Locality Pyramid mountain.
Reference

I. FIELD NOTES
Occurrence: Upper Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION
Color: f.s. light bluish grey, 5B 7/1. w.s. brownish grey, 5YR 4/1.
Grain size: very fine.
Texture: laminated.
Alteration: stained.

III. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture:
Structure: original clastic, secondary voids of weathered out crystals seen

PRIMARY MINERALS %	SECONDARY MINERALS %	METAMORPHIC MINERALS %
Essential quartz.	Alteration products (z) limonite. chlorite.	biotite.
Varietal (x) sericite.	GROUNDMASS OR CEMENT	MINERALIZATION tourmaline.
Accessory (y) magnetite.		

SPECIAL FEATURES:
Quartz is very fine grained.

Fractures transect the laminae. These are primary as they have been filled with clastic material.

The limonite occurs around the voids. Presumably these voids were filled with pyrite as pyrite is seen in the hand specimen.

One half of the slide is dominantly argillite containing biotite and magnetite. The other half of the slide is argillaceous quartzite, with a few laminae of more argillaceous material tending to show graded bedding.

See photograph following page 33.

CLASSIFICATION Argillaceous quartzite.

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A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-27.
Locality Pyramid mountain.
Reference

I. FIELD NOTES

Occurrence: Upper Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION

Color: f.s. bluish white. 5B 9/1. w.s. brownish grey, 5YR 4/1.
Grain size: fine.
Texture: roughly banded.
Alteration: stained.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: granular.
Structure: original clastic. secondary schistose.

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	55%	limonite. kaolin.		chlorite.	10%
Varietal (x)					
sericite.	30%	GROUNDMASS OR CEMENT		MINERALIZATION	
				tourmaline.	
Accessory (y)					
magnetite. zircon.	3%				

SPECIAL FEATURES:

All elongate minerals except tourmaline are lineated.

Quartz is very fine grained.

Some of the chlorite appears to contain evidence of minute radioactive minerals.

CLASSIFICATION Micaceous chlorite schist.

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A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-28.
Locality west of St. Mary
Reference Lake.

I. FIELD NOTES
Occurrence: Upper Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION 5B 7/1.
Color: f.s. light bluish grey, w.s. light grey, n-7.
Grain size: very fine.
Texture: laminated.
Alteration: stained.

III. MICROSCOPIC STUDY FOR CLASSIFICATION
Texture:
Structure: original clastic, (laminated). secondary

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	30%	limonite.			
sericite.	65%	kaolin.			
		chlorite.			
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
				tourmaline.	
Accessory (y)					
magnetite.	2%				

SPECIAL FEATURES:

The voids of some weathered out crystals (pyrite-?) are partially filled in some instances with limonite.

Some laminae have an excess of sericite over that amount of sericite contained in other laminae.

All the constituents are very fine grained.

CLASSIFICATION Argillite.

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A. Berry.

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PETROGRAPHIC DESCRIPTION

Date Collected
Collector

Specimen No. 50-29.
Locality Pyramid mountain.
Reference

I. FIELD NOTES

Occurrence: Upper Aldridge.
Question:

II. HAND SPECIMEN DESCRIPTION 5B 5/1.

Color: f.s. medium bluish grey, w.s. medium light grey, n-6.
Grain size: very fine.
Texture: banded.
Alteration: none.

III. MICROSCOPIC STUDY FOR CLASSIFICATION

Texture: ---
Structure: original clastic, (banded) secondary ---

PRIMARY MINERALS	%	SECONDARY MINERALS	%	METAMORPHIC MINERALS	%
Essential		Alteration products (z)			
quartz.	30%	kaolin. limonite.		biotite. muscovite.	10% 5%
Varietal (x)					
		GROUNDMASS OR CEMENT		MINERALIZATION	
		chlorite. -- sericite. --	50%	pyrrhotite.	4%
Accessory (y) tourmaline. magnetite. zircon.					

SPECIAL FEATURES:

A wide banded effect persists. This banded effect appears to be due to the accumulation of kaolin and possible very fine magnetite.

There is a very fine groundmass which appears to be composed of chlorite and sericite.

CLASSIFICATION Argillite.

PETROGRAPHER
A. Berry.

ST MARY LAKE

KOOTENAY DISTRICT
BRITISH COLUMBIA

116° 30'
49° 45'

LEGEND

CENOZOIC

MODERN
RECENT AND PLEISTOCENE

Glacial drift, silt, sand, gravel

PRECAMBRIAN

LOWER PURCELL SERIES

KITCHENER FORMATION green, grey and purple, buff weathering, dolomitic argillite

CRESTON FORMATION green, purple and white, argillaceous quartzite, and quartzite.

UPPER ALDRIDGE. rusty weathering; finely laminated argillaceous quartzite.

MIDDLE ALDRIDGE: rusty and grey weathering, massive and thinly bedded quartzite and argillaceous quartzite.

LOWER ALDRIDGE. rusty weathering, thinly lined quartzite and argillaceous quartzite.

CRETACEOUS.

Granite.

PRECAMBRIAN.

Purcell Intrusives; diorite sills and dykes.

(Geological boundary (located, approximate, assumed)

West Fork
North Fork
East Fork
Pyramid
Creek
St. Mary River
Lumber Camp
Redding Creek
Hall Creek
Lower Creek
Elk Creek
25°
10°
8000
7000
6000
5000
4000
3000
2000
1000

ST MARY LAKE

KOOTENAY DISTRICT
BRITISH COLUMBIA

116°

49° 45'

Sullivan Hill.

Mark Creek

Matthew Creek

North Star Hill

Bear Creek

Bootleg Mt.

8530

8000

7000

6000

5000

4000

Alki Creek

St Mary River

St Mary Lake

Sawmill

CRETACEOUS.

Granite.

PRECAMBRIAN.

Purcell Intrusives; diorite sills and dykes.

Geological boundary (located, approximate, assumed)

Bedding (inclined, vertical, horizontal, overturned)

Fault (located approximate, assumed)

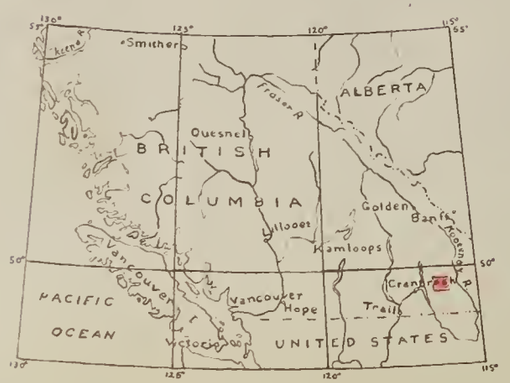
Mine tunnel

Road

Trail

Bridge

Approximate magnetic declination, 24° East.



Scale, 1 Inch to 200 Miles

Creek

Redding Creek

Tower Creek

Meacham Creek

Mt. Evans 8949'

Fiddler Creek

Mt McKay

Hellroaring Creek

4000

5000

6000

7000

8000

49° 30'

116° 30'

Scale, 1/63,360 or 1 Inch to 1 Mile

Miles 0 1 2

Contour interval 500 feet

Elevations referred to Mean sea level

St. Mary River

St Mary Lake

Sawmill

Alki

Creek

7000

6000

5000

4000

Mt. Evans. 8949'

Fiddler Creek

Hellroaring Creek

Angus Creek

Cabin

Sawmill Creek

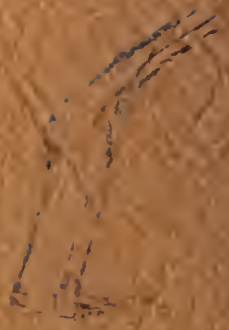
Berry Creek

49° 30'

116°

Scale, 1/63,360 or 1 Inch to 1 Mile

Miles 0 1 2 3

Contour interval 500 feet

Elevations referred to Mean sea level